ACUTE INFANTILE INTUSSUSCEPTION.

Being a Thesis for the Degree of M.D.
Edinburgh University.

by

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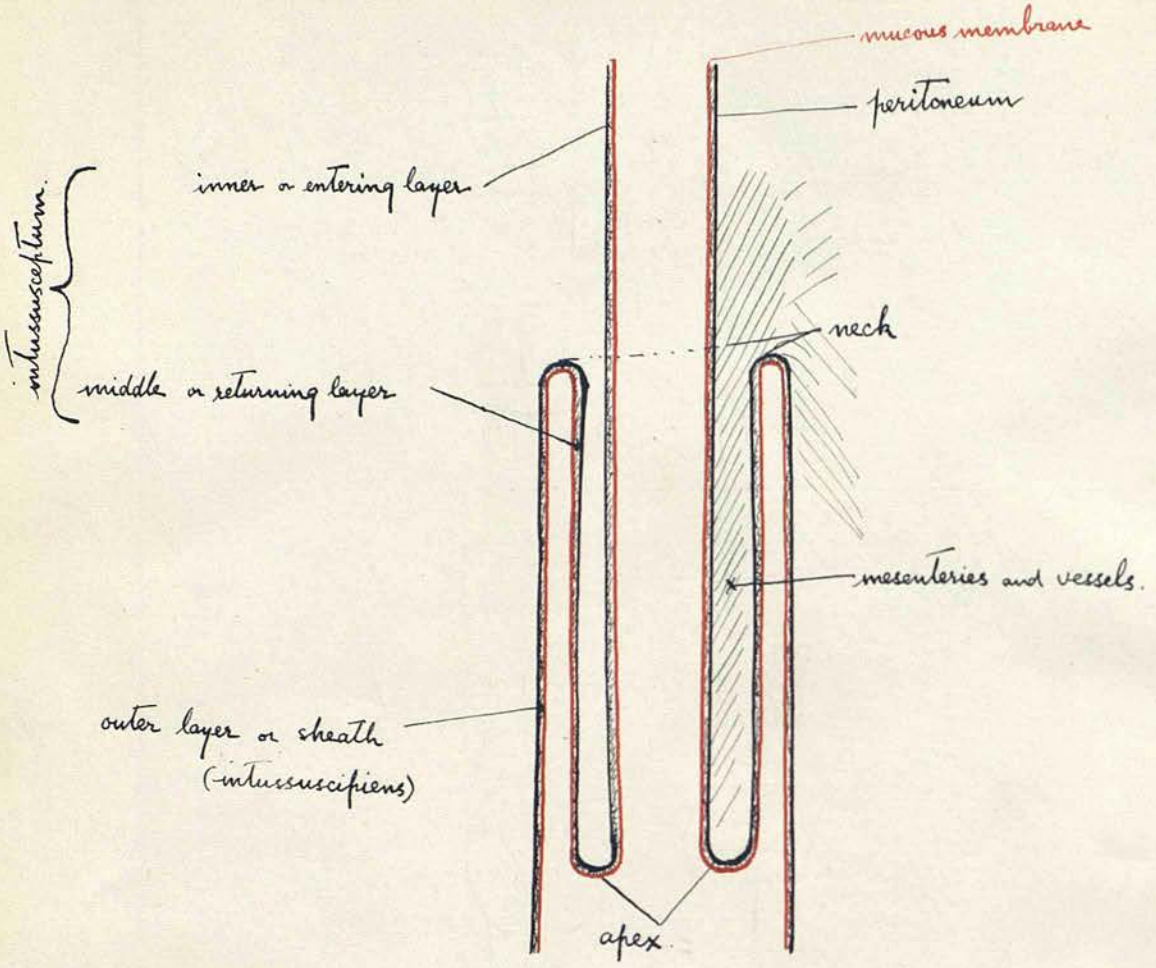
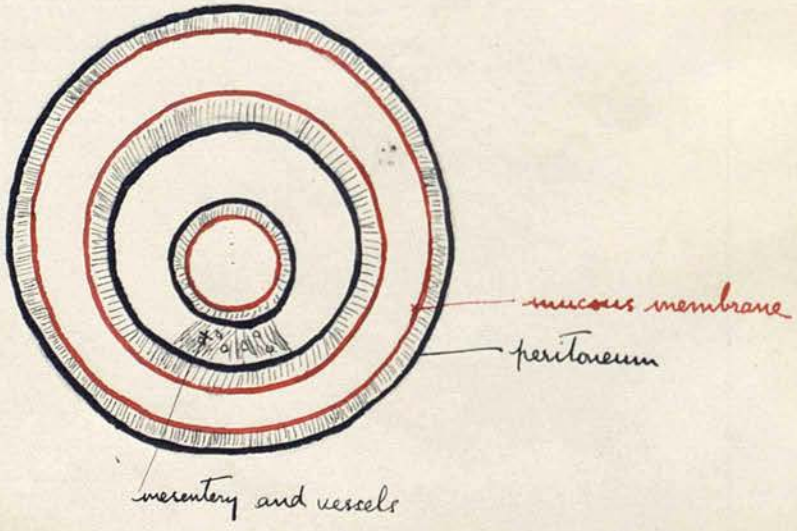
ACUTE INFANTILE INTUSSUSCEPTION.

While Resident Surgeon at the Edinburgh Royal Hospital for Sick Children during the winter 1903-1904, I had the good fortune to see no fewer than seven cases of Acute Intussusception in infants; and on searching the Hospital Records as far back as the beginning of 1898, I found that in addition there were accounts of over forty cases of this condition - valuable material which as far as I am aware has never been systematically analysed. I took the opportunity, also, of consulting various text books, and looking up numerous published articles on intussusception, with the result that I found the most divergent opinions expressed as regards the treatment of the disease. For this reason and because of the great pathological and clinical interest attached to intussusception, I decided to take the material at my disposal as a text for a careful consideration of the whole subject.

The importance of intussusception as a cause of obstruction of the bowels can hardly be over-estimated. If we class together all kinds of obstruction at all ages, it is found to form one third of the

Fig. I


mucous membrane
peritoneum
intussusceptum
inner or entering layer
neck
middle or returning layer
mesenteries and vessels.
outer layer or sheath
(intussuscipiens)
apex


mucous membrane
peritoneum
mesentery and vessels

cases. In children the proportion is very much higher, over three quarters of the cases of acute obstruction in early life being due to intussusception.

Intussusception is the turning or prolapse of one portion of the bowel into an immediately adjoining portion. The part invaginated acts as a foreign body to the engulfing portion and is moved downwards by the active peristalsis of the latter with a consequent enlargement of the tumour.[1] A longitudinal section of such an invagination presents six layers of bowel - three on either side of the lumen (Fig.I.) The outer layer forms the sheath, intussuscipiens, or receiving layer. The middle or returning layer formed by an infolding of the outer: and the inner or entering layer together form the intussusceptum. The different cylinders of bowel are so arranged that peritoneum is always in contact with peritoneum, and mucous membrane with mucous membrane. A transverse section would show three concentric rings of bowel. The part at which the sheath is folded on itself to become continuous with the returning layer, is termed the neck. The most distal portion of the intussusceptum where the returning and entering layers join, is known as the apex. The included mesenteries

1. See an interesting paper by John Hunter on "Introsusception" 1789.

lie between the entering and returning layers, i.e. between the layers of the intussusceptum. In infants a simple invagination invariably occurs in the direction of the normal peristalsis: but double and even triple intussusceptions may be formed, usually by foldings of the sheath,and these secondary invaginations may occasionally be retrograde. It is obvious that these complex varieties will present five and seven layers of bowel respectively instead of three. Intussusception may occur at any part of the intestinal canal, although it is chiefly with the ileum and colon that we have to deal, and I wish first of all to consider briefly the anatomy of the bowel and its mesenteries as far as it affects the subject.

ANATOMY:

The small intestine is arranged in coils which are largely superficially situated and roughly speaking, the coils of jejunum are in the umbilical, left lumbar, and left iliac regions; those of the ileum in the pelvis, the hypogastrium, the right iliac and right lumbar regions. During the first few months of life no small intestine is found in the pelvis on account of the relatively large size of the pelvic colon and small dimensions of the pelvis. Treves[1]

1. The Anatomy of the Intestinal Canal and Peritoneum in Man. Hunterian Lectures 1885.

states that during the first three years of life this arrangement of the coils of small intestine,in the form of a curve from left to right with the convexity downwards,is more constant than in later years. This fact might be of some help in determining the part of gut affected in an enteric intussusception. At birth the small intestine averages about six feet. During the first month it grows two feet and during the second month two feet, after which the rate of increase is irregular. The small intestine is attached along its whole length to the posterior abdominal wall by means of an ample mesentery, the root of which is remarkably short, extending from the left side of the body of the second lumbar vertebra obliquely downwards and to the right across the vertebral column for about six inches to end in the right iliac region. The length of the mesentery from its attachment to the bowel back to the vertebral column varies from eight to nine inches in the adult. It is composed of two layers of peritoneum between which enter the vascular, lymphatic and nervous supply of the bowel. The upper or right layer is continuous above with the lower layer of the transverse mesocolon and with the peritoneum investing the ascending colon: the lower or left layer merges to the left with the peritoneum descending

into the pelvis and with that covering the descending colon and forming the mesentery of the pelvic colon. The arrangement of these layers in the right iliac region will be dealt with along with the caecum and ascending colon. The length of the mesentery and the superficial position of the coils of small intestine account for the great mobility of enteric intussusceptions and the ease with which they can be palpated. The mobility of the ileum explains the distance that this part of the gut may travel when included in an ileocaecal invagination: indeed, the size of an intussusception must depend to some extent on the length and extensibility of the mesentery. D'Arcy Power[1], on measuring the mesentery in 44 children of different ages found that its length was remarkably constant and that, therefore, in proportion to the size of the body, the mesentery is longer in infants than in older children, a fact of no small significance when we remember that the large rapidly travelling ileocaecal invaginations are practically confined to infant life. The same observer noted that in some cases the mesenteric glands are small, discrete and seedlike; and that in others they are aggregated into large lymphoid

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1. Hunterian Lectures, 1897.

masses. This will certainly have some bearing on the rate of congestion of the intussusceptum and the acuteness of the onset of symptoms.

The angle at which the ileum enters the caecum is found to vary considerably in different individuals, and it is conceivable that this angle of incidence may have some effect in the induction of ileocaecal invaginations (Fig.II). When the last few inches of ileum slope upwards, forming an acute angle with the caecum, a prolapse of the ileocaecal valve into the colon would be directed upwards and would lie in such an attitude that the peristalsis of the colon would tend to increase the tumour by drawing it upwards towards the hepatic flexure. In those cases, on the other hand, in which the ileum descends at its finish to form an obtuse angle with the caecum, any prolapse into the lumen of the large bowel would point downwards, and the effect of peristalsis would be to reduce the commencing invagination by pushing it up, and thus prevent the formation of an intussusception. Treves[1] states that the small intestine usually ascends to its termination. D'Arcy Power[2] noted the angle in 38 bodies and found that in 20 the axis of the ileum was horizontal; sloping upwards in 15, and sloping downwards in 3.

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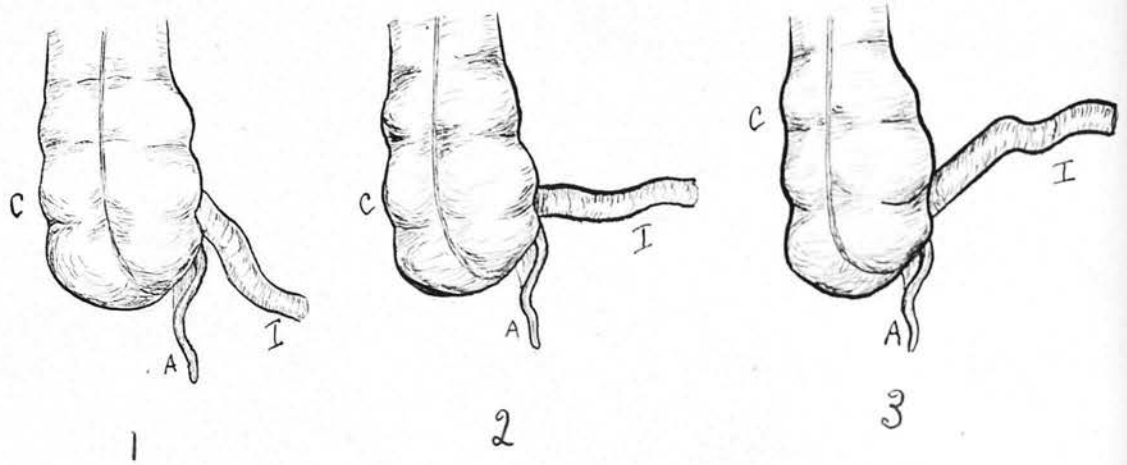
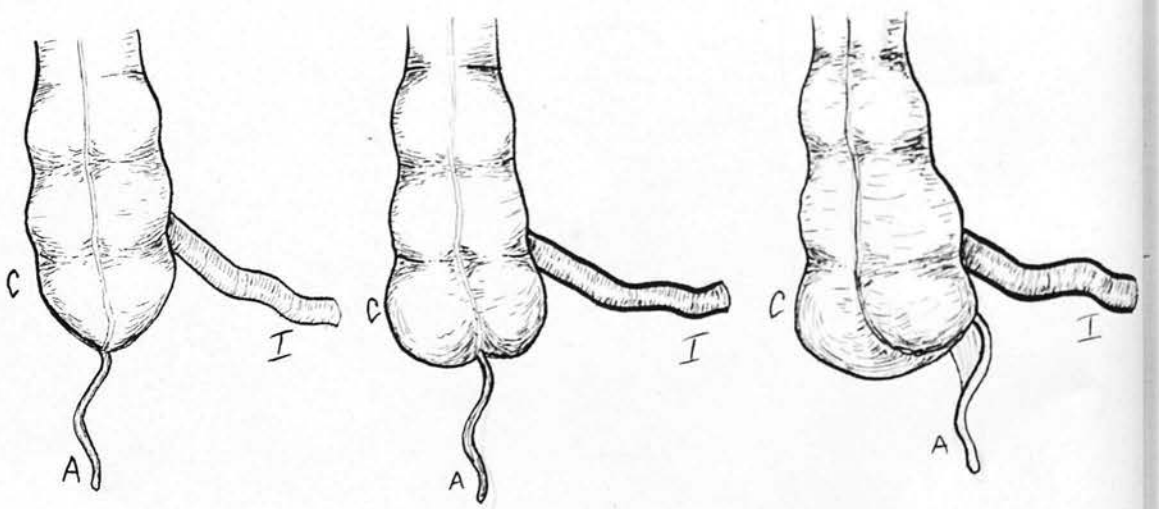
1. Op. cit.
2. Op. cit.

Fig. II



1 2 3

Fig. III



1 2 3

As already stated, the terminal coils of the ileum descend into the pelvis about the end of the fourth month, and as the original angle of incidence is practically horizontal, it seems probable that this descent will cause the termination of the ileum to lie in a position of ascent towards the caecum for a time at least: and it is just during the months following the date when this descent is known to take place that acute infantile intussusception is most common.

The large intestine at birth is a little over two feet in length, and nearly half of this is accounted for by the large pelvic colon. At the end of the fourth month the measurement is exactly the same; but the ascending, transverse and descending colons are found to be longer by several inches, the growth having taken place at the expense of the pelvic colon which has shortened to a corresponding extent. After this date the growth is steady and regular. At the end of the first year it measures about two and a half feet and at the end of the sixth year about three feet. In a new born infant the large intestine is practically of the same diameter as the small. During the first twelve months the growth in calibre of the colon is relatively enormous, particularly in the case of the caecum.

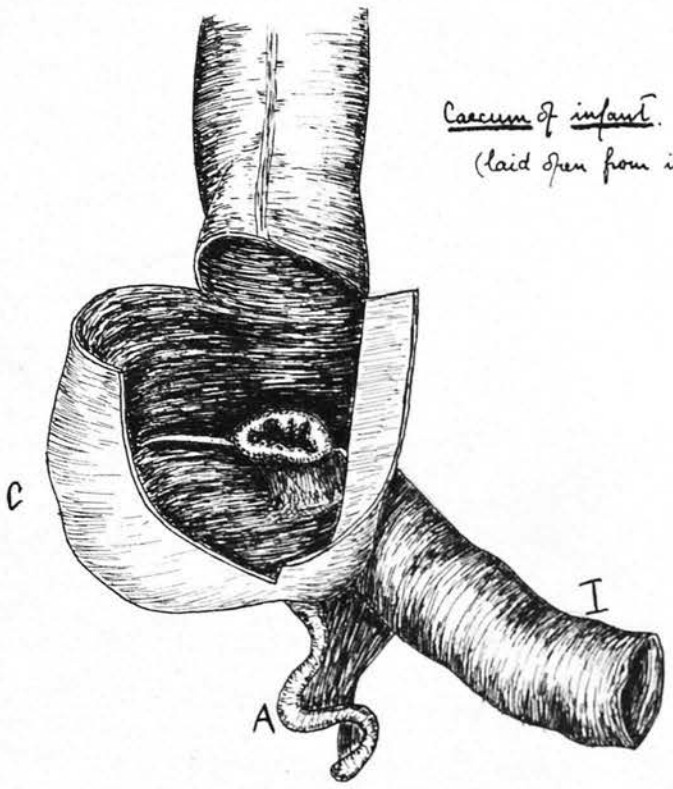
At the age of fifteen years, the colon is about three times greater in diameter than the ileum.

The caecum is usually taken to be that portion of the colon lying below the level of the lower margin of the termination of the ileum. During the later months of foetal life, it descends from its position in the right hypochondrium, and is found at full time in the right iliac fossa. In this way is formed the ascending colon, and during its descent the caecum becomes completely surrounded with peritoneum. The caecum thus has no mesentery, and, as far as I have been able to discover, there is no authentic case on record in which one has existed. To this, in part, it owes its great mobility. At birth the caecum is conical in shape. The internal, the anterior and the postero-external longitudinal muscular bands are equidistant and from their point of union at the extreme apex the appendix comes off. This state of matters may exist throughout life, and then we have what is known as the foetal type of caecum. The enlargement of the caecum takes place by the growth of the portions between the longitudinal muscular bands, and three saccules are formed. Rarely these saccules may grow equally and then the apex with the appendix retains relatively its original position. In the vast majority of cases the

saccule between the anterior and the postero-external bands grows out of all proportion to the others. The apex with the appendix becomes displaced inwards, upwards and backwards, and this antero-external pouch comes to form the real apex of the caecum (Fig.III.) In some cases the growth of this pouch may be relatively so great that the appendix appears to spring from immediately below the ileocaecal junction.
All authorities are agreed that variations in the anatomical arrangement of the colon are of great aetiological importance in intussusception. During the first months of life the colon,and particularly the caecum, are in a constant state of growth and change of shape: and during this time its walls, especially, as may often happen, when this growth oversteps physiological limits and becomes excessive, will be weak, unsuited to withstand abnormal influences and prone to disturbances of function from slight causes.

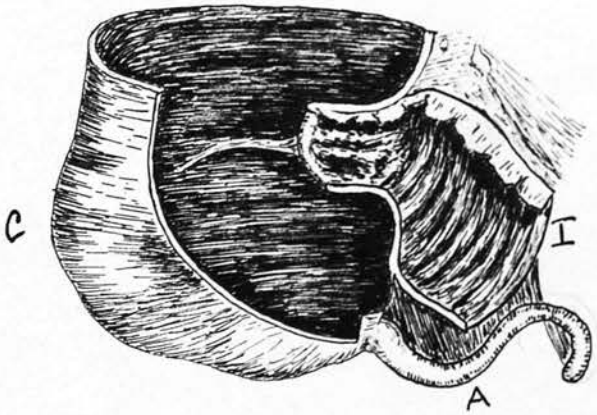
The orifice of the ileum on the postero-internal aspect of the caecum is guarded by the ileocaecal valve which prevents regurgitation from the large to the small intestine. The valve consists of two semilunar folds formed by a reduplication of the mucous membrane and circular muscular coat. One of them is attached superiorly and the other inferiorly,

Fig. IV



Caecum of infant.
(laid open from in front)

Fig. V



Caecum of infant
(Ileocaecal junction and valve divided vertically)

the aperture between them being transverse in direction. At each side of this aperture the segments of the valve coalesce and are continued for a varying distance round the wall of the caecum in the form of horizontal ridges known as retinacula. The segments of the valve project into the lumen of the caecum during the passage of bowel contents from the ileum and this may be looked upon as their normal attitude; but when the colon and caecum become distended the retinacula pull on the flaps and close the aperture. The ileocaecal valve forms the original apex in cases of ileocaecal intussusception, or in other words is the starting point of the process. I am convinced that the presence of this valve, in conjunction of course with other factors, is of aetiological importance. I have examined the valve at numerous post mortems on infants by opening the caecum from the front and thus getting a view of the orifice in situ. The first point to be noted is that the mucous membrane lining the valve segments has a peculiar puckered appearance and projects slightly into the lumen of the colon (Fig.IV.) On making a mesial vertical section through the valve in the axis of the entering ileum, this appearance is seen to be due to a longitudinal folding of the mucous membrane - in marked contrast to the transverse

Fig. VI

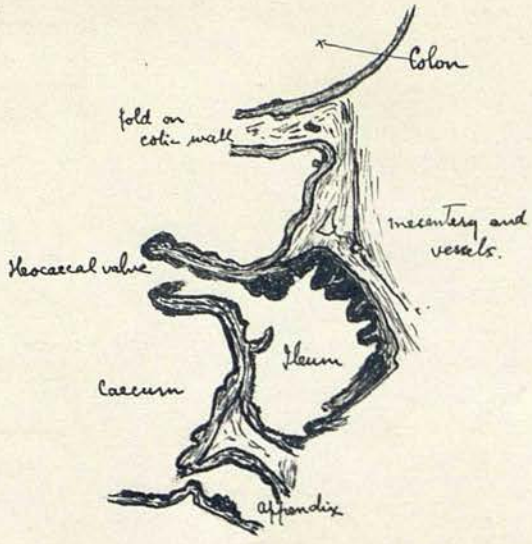
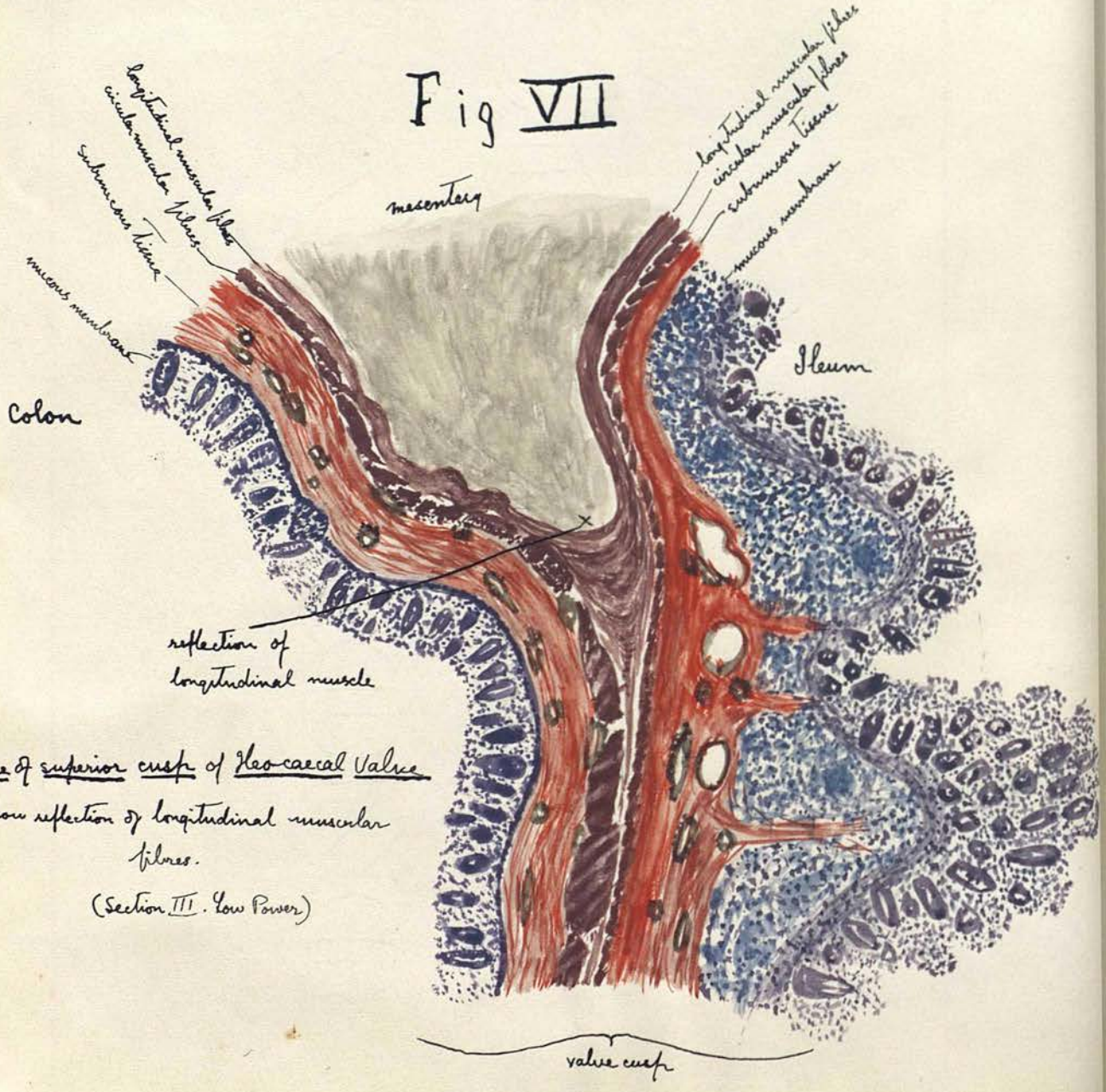


Fig VII



Base of superior cusp of Ileo-caecal Valve
To show reflection of longitudinal muscular fibres.
(Section III. Low Power)

ridges of the ileum (Fig.V.). I have had sections made of the caecum of a child aged 6 months which shows the typical arrangement (Fig.VI.). Microscopically (Section I.) it can be seen that this puckered mucous membrane has beneath it an exceedingly loose submucous tissue. In other words, the mucous coat of the valve is redundant and loose, and might easily under favourable circumstances prolapse into the lumen of the large bowel. I have never myself seen a condition that could fairly be termed prolapse: but in a few of the 44 children's bodies that D'Arcy Power examined, the mucous membrane was distinctly prolapsed. Such a state of matters is not described as occurring in adults, and in about half a dozen adults whom I have examined post mortem, I have never found the same condition - at any rate never anything like as marked as in the rule in the infant. The importance of this is obvious. A prolapsed mucous membrane might easily be seized upon by the contracting colon and, other things being equal, form the starting point of an ileocaecal intussusception. The second point of note is the extraordinary projection of the termination of the ileum into the colon.(Fig.V. and Sections I.,II.,III.) I have read somewhere recently, although I cannot now find the reference,that the ileocaecal valve in

children is rudimentary and of little account. D'Arcy Power does not discuss this matter clearly, but he seems to support that view when he states that the aperture is usually round or oval, and speaks of the ileum as projecting from 4 to 7 millimetres into the colon. At first sight it would appear that this were so, but on closer study I think it will be seen that the larger part of the projection is formed by the valve itself which is large and well developed. The valve segments only contain circular muscular fibres and the base of each cusp may be said to be situated at the point of reflection of the longitudinal fibres from the ileum on to the caecum and colon respectively. This is well seen in Section III. at the base of the superior cusp. Fig.VII. represents a rough sketch of this section. Some of the longitudinal fibres appear in the section to run a little way on between the converging circular coats of the ileum and colon after the main mass has been reflected, but this, of course, is due to a slight obliquity of the section. In this specimen, then, the valve segments account for fully fourth-fifths of the projection into the large bowel: and as the naked eye appearance was typical, there is no reason to suppose that microscopically the condition is abnormal. This projection is relatively out of all proportion to what is found in adult life; and, apart from the above facts, I think

it is more reasonable to suppose that in infants the valve is strongly developed,and that later the wall of the colon grows out of proportion to it, than to assume that there is a sort of static invagination of ileum into colon which recedes as development goes on. The projection,at any rate, must constitute one of the strongest predisposing anatomical factors to intussusception and when it is well marked, one might almost say that there is a constant incipient intussusception in existence.

The remaining portions of the colon require little notice. Their greatest importance anatomically, from the point of view of intussusception, lies in the situation of the different sections. As a whole the wall of the colon is puckered and pouched, and this explains the frequency of secondary invaginations when the colon forms the sheath of an intussusception. The descending colon is the most constant in position and length on account of its being a primary bowel loop. The hepatic flexure may occasionally be absent, the colon running obliquely across the abdomen from the caecum to the splenic flexure. Such a condition is a persistence of the arrangement found in a four months foetus after the descent of the caecum from the right hypochondrium. The splenic flexure is higher in posi-

tion than the hepatic and more deeply situated. The transverse colon varies considerably in position and mobility. In children up to two years of age it frequently shows a sharp bend with the convexity downwards just to the left of the middle line.

The variations occurring in the peritoneum covering the colon and forming its mesenteries are of very great interest in connection with the formation and course of intussusceptions involving the large bowel. The transverse colon and the pelvic colon invariably possess mesenteries and these portions have, therefore, a large range of movement. The caecum, as already stated, is completely surrounded by peritoneum and has no mesentery. In 100 bodies Treves[1] found that contrary to the usual statements in books, a mesocolon on the left side is more common than on the right. His actual figures are:-

Descending mesocolon (no ascending) 22%.
Ascending mesocolon (no descending) 12%.
Both descending and ascending 14%.

Where no colic mesentery is present the peritoneum is reflected directly from the side of the colon on to the abdominal wall and a larger or smaller portion of the posterior wall of the gut is in

1. Op. cit.

direct contact with the posterior parietes. When an ascending mesocolon is present, its layers are directly continuous with those of the enteric mesentery; the right or outer layer being a continuation of the left or lower layer of the mesentery, and the left or inner layer a continuation of the right or upper layer of the mesentery. The absolute continuity of these mesenteric folds can easily be demonstrated at post-mortem examinations or during operations by pulling the gut at the ileocaecal angle downwards and outwards, by which means the peritoneum is put on the stretch. The lower inch or two of the colon is usually completely surrounded by peritoneum like the caecum, the reflection in this plane not reaching as far down as the entrance of the ileum. In these cases it is obvious that the caecum is anchored to the posterior parietes solely by the ascending mesocolon and its mobility, as well as that of the colon itself, will depend upon the length of the colic mesentery. The ascending mesocolon is attached below along the lower margin of the kidney, and above along the inner margin of that organ. When there is no ascending mesocolon the gut is firmly fixed to the anterior aspect of the lower end of the kidney and to the parietes along its inner margin by the reflection of the peri-

toneum on either side. Treves states that an ascending mesocolon is rare during foetal life and not so common at birth as in the adult. D'Arcy Power as a result of his investigations has shown that the mesenteries of infants are relatively much longer than those of older children. At a recent operation at the Edinburgh Children's Hospital, the sac of a left inguinal hernia in an infant was found to contain caecum and appendix. In this case there must have existed an exceedingly long ascending mesocolon. In inguinal hernias, on the right side in children, it is quite common to find caecum and even part of ascending colon. Even if we admit that an ascending mesocolon is rare in children, we are justified in concluding that when it does occur, it is long and allows of free movement. Without an ascending mesocolon it is impossible for an ileocaecal invagination to form at all, or at any rate to attain any dimensions. The ileum and caecum might become invaginated so as to form the commencement of an intussusception, but further progress would be stopped, because an intussusception grows by the infolding of the wall of the colon and its consequent movement in the direction of the rectum; and such infolding and movement could not take place were the ascending colon firmly fixed to the posterior parietes. In such individuals there are only

three possibilities:-

I. That an intussusception begins and is unable to proceed further. A case of this kind must be extremely uncommon, as I can find no record of one.

II. That it begins, but only being an inch or two in length, it spontaneously reduces itself. There can be no absolute proof one way or the other of such occurrences.

III. That intussusceptions do not occur in individuals who have no ascending mesocolon.

This last, to my mind, is by far the most likely explanation. If we grant this, then we must accept the logical consequence, namely, that mobility of the caecum is of essential importance as a predisposing factor in intussusception: because, as I mentioned above, such mobility depends to a large extent on the presence or absence of an ascending mesocolon, and as far as I can see, the presence of a mesocolon could have no other results which would affect the origin of invaginations..... The transverse mesocolon is always ample enough to allow of any amount of invagination, and it can present no obstacle to the onward course of an intussusception. If the descending mesocolon be absent, the descending colon can take no part in the formation of the intussusception, and the further progress must cease, although of course, the tumour already formed may project for a considerable distance down the lumen of the descending colon, the latter forming the sheath. Such a

Fig. VIII

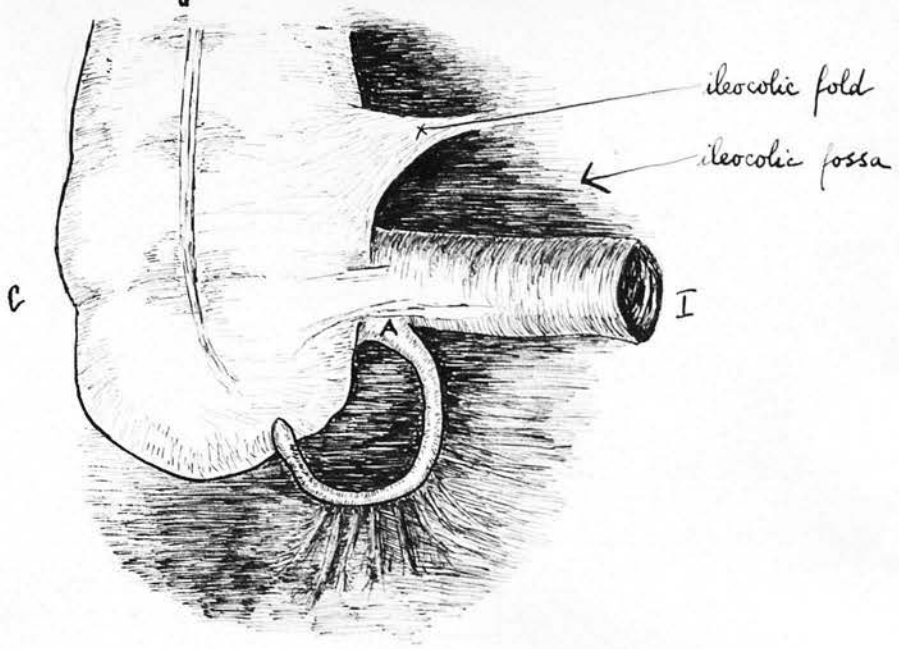


Fig. IX

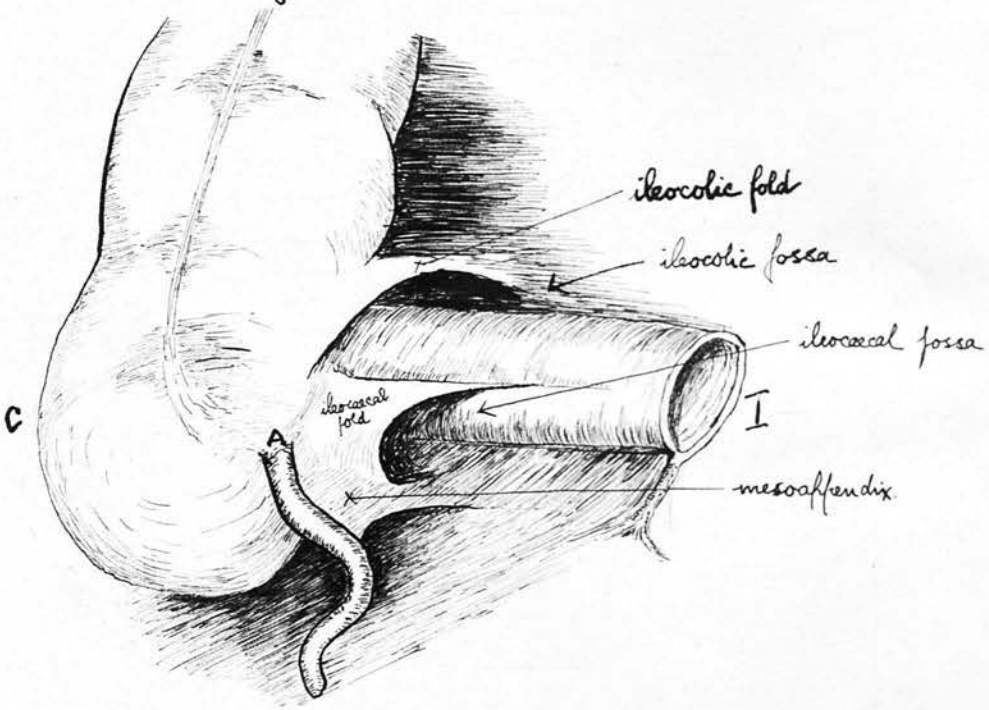
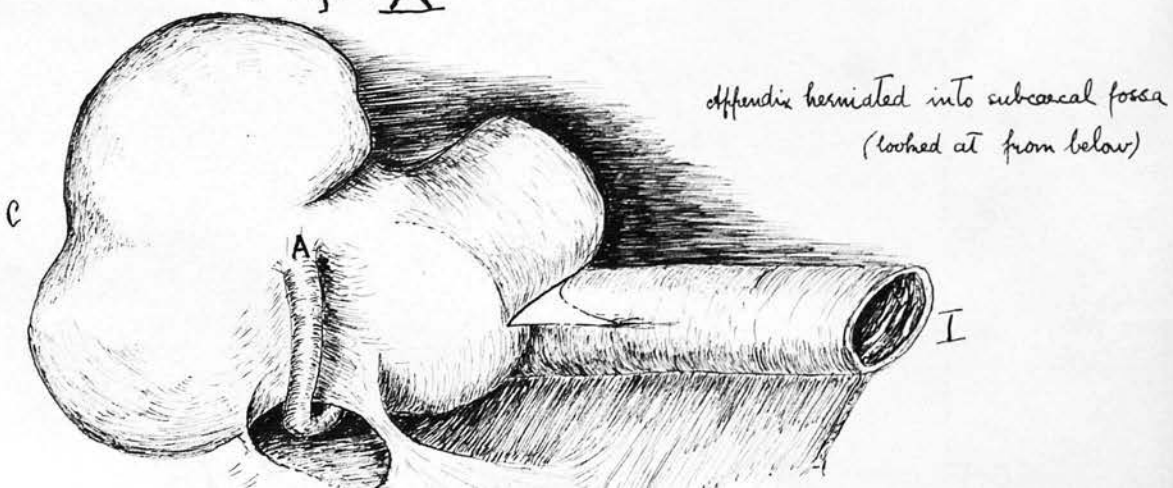


Fig. X



state of matters would be found where the ascending mesocolon was present, but the descending absent. When the descending meso colon is present and of sufficient length or extensibility, there is nothing to prevent the downward course of the tumour, the apex of which may eventually project from the anus.

Attention has been drawn by D'Arcy Power to the complexity of the peritoneal folds in the ileo-caecal region and their importance in intussusception. The anatomy of the parts has been fully described by Lockwood and Rolleston[1], and I reproduce here their diagrams to simplify the explanation of the various fossae. The ileocolic angle may be covered in anteriorly by a triangular piece of peritoneum called the ileocolic fold which transforms the angle into a fossa (Fig.VIII.). Behind the ileocaecal angle there is a fossa running upwards parallel with the colon and this fossa may be subdivided by the presence of an ileocaecal fold and a mesoappendix (Fig.IX.). Lastly, at the base of the caecum, and posteriorly, a pouch runs upwards behind the ascending colon for a short distance, and this is termed the subcaecal fossa. (Fig.X.). These folds must all be drawn into an ileocaecal intussusception and the degree of their size, vascularity, and com-

1. Journal of Anatomy and Physiology. Vol.XXVI.

plexity must to a certain extent determine the rate of congestion of the intussusception and the acuteness of the symptoms resulting thereupon.

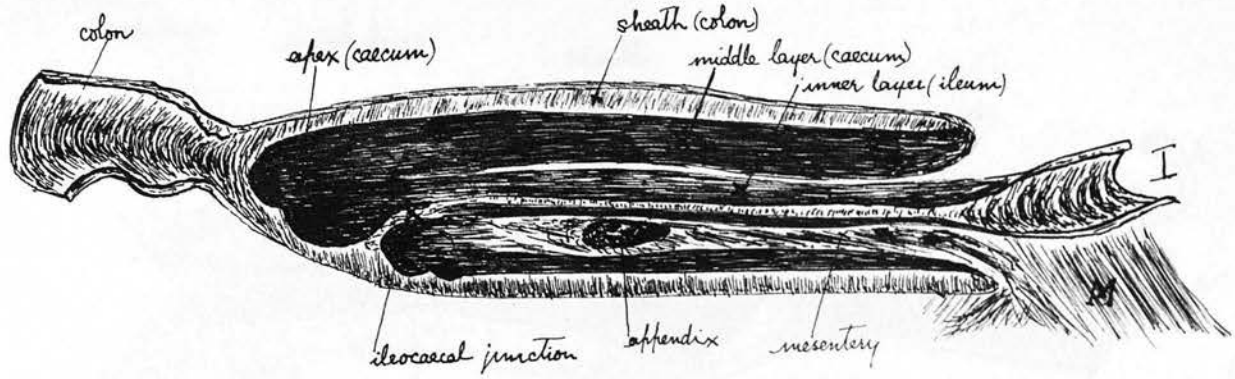
The vermiform appendix is invariably included in ileocaecal intussusceptions. The mesoappendix is variable. Sometimes it is absent altogether. When present it may spring from the lower layer of the mesentery, from the colon, the caecum, or the iliac fossa.

One point in the physiology of the ileocaecal part of the gut is worth mentioning. It is known that the peristaltic waves of the ileum cease at the ileocaecal valve and that a fresh and independent peristalsis starts in the caecum. There will thus frequently occur in this region a state of matters which greatly favours the formation of intussusceptions, namely, a firm contraction of one portion of the bowel associated with a relaxation of the portion immediately adjoining it.

PATHOLOGY:

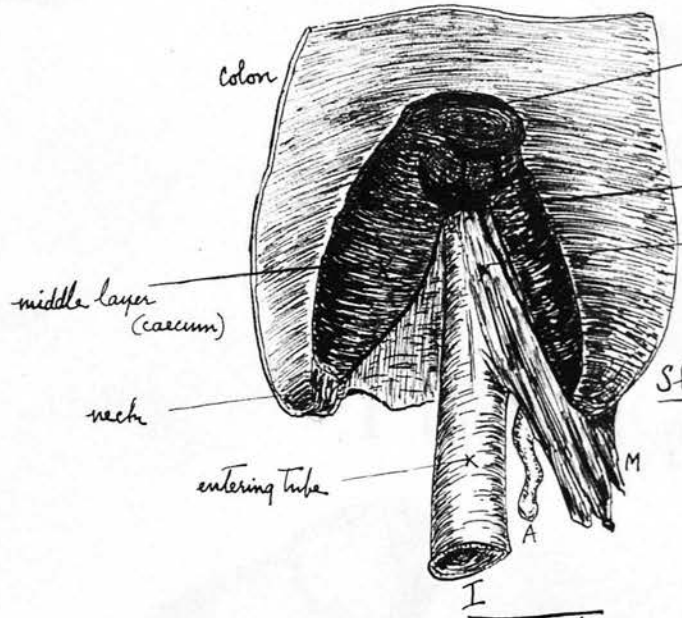
I propose to deal first with the general pathology, and then to discuss the more minute changes occurring in the portions of bowel involved in an acute intussusception. Four distinct varieties of invagination are recognised:-

Fig XIII



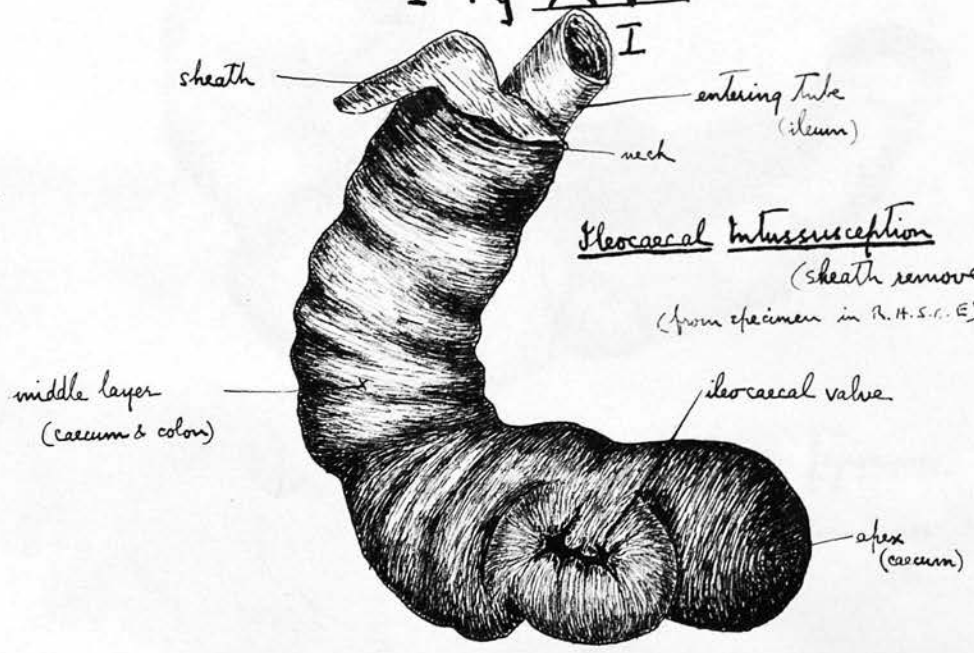
Longitudinally sectioned Ileocaecal Intussusception
(from specimen in R.H.S.C.E.)

Fig XIV



Short Ileocaecal Intussusception
sheath laid open; middle layer slit up from neck.
(from specimen in R.H.S.C.E)

Fig XV

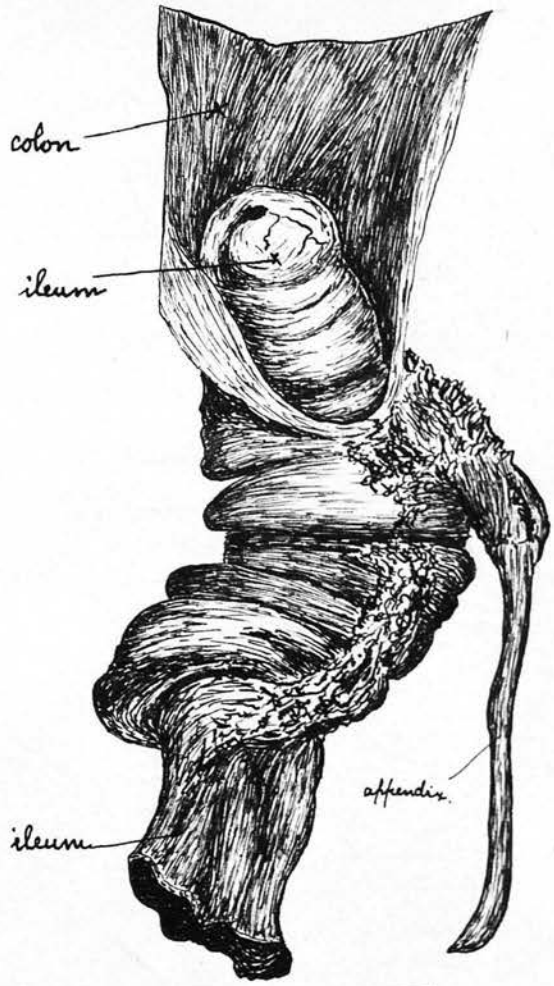


Ileocaecal Intussusception
(sheath removed)
(from specimen in R.H.S.C.E)

I. Enteric (Figs. XI. and XII.). These are most frequent in the lower part of the jejunum. The next most common site is the ileum, in the proportion of about 4 of the former to 1 one the latter. They are usually short, involving not more than a few inches of the bowel. This is what one would expect, for the included part of the gut is of the same diameter as the sheath, and a sort of impaction occurs from the intense congestion and swelling. They are, as a rule, superficially situated and extremely mobile on account of the length of the mesentery.

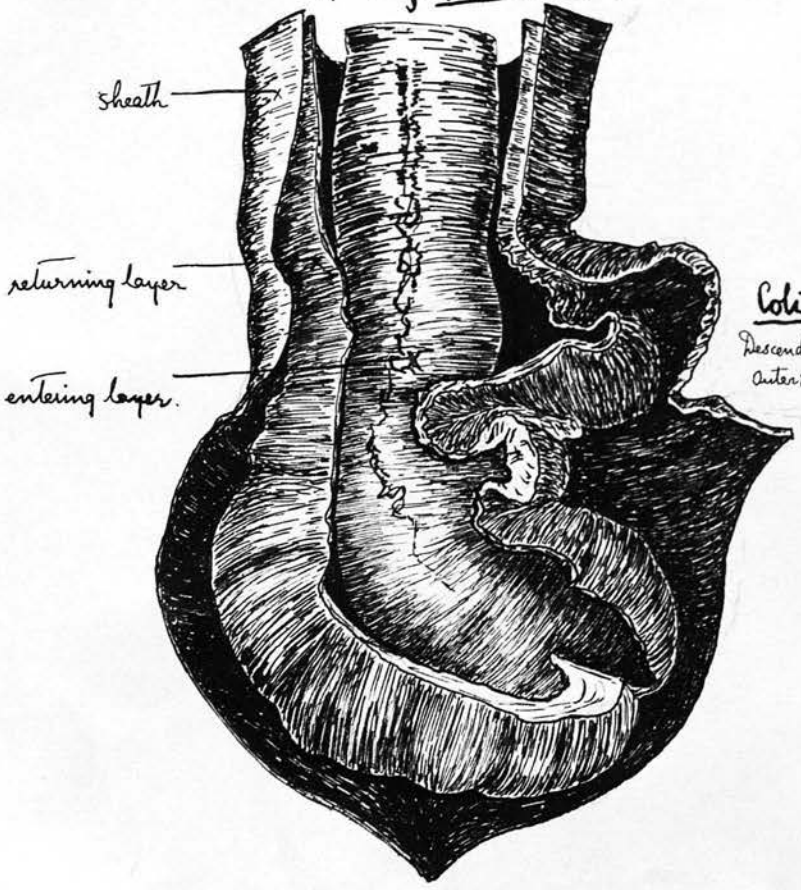
II. Ileocaecal. (Figs. XIII.,XIV.,XV., Section IV.). These comprise a very large majority of the total cases. The ileocaecal valve forms the original apex and the valve,or some portion of the caecal wall adjoining it,travels foremost throughout the invagination's progress. The ileum is pulled in after it and the increase in length of the tumour is accounted for by an infolding first of the caecum and then of the colon. The apex is a more or less constant quantity, but the neck is always changing, the sheath or intussuscipiens being steadily turned in to form part of the intussusceptum. This is the mechanism of growth in all intussusceptions, except the ileo-colic. The ileocaecal variety attains

Fig. XVI



Ileocolic Intussusception
colon laid open
(from Treves: "Intestinal Obstruction")

Fig. XVII



Colic Intussusception
Descending colon into Sigmoid Flexure
Outer & middle layers laid open.
(from Treves: "Intestinal Obstruction")

greater dimensions than any other form. It is not uncommon to find that the ileocaecal valve has traversed the whole colon and rectum and protruded from the anus.

III. Ileocolic: This is an extremely rare variety. The terminal portion of the ileum is prolapsed through the ileocaecal valve; and it is supposed that the tumour grows in length by more and more of the ileum (entering layer) being prolapsed through the valve. Some portion of the terminal part of the ileum forms the apex and - unlike any other form of intussusception - the apex is a constantly changing quantity. It seems possible that this mechanism might take the place of that of the ordinary ileocaecal variety where there is no ascending mesocolon, and the sheath is prevented from being folded in at the neck by the fixity of the colon. Cases of ileocolic intussusception are exceedingly severe and acute on account of the tight grip that the orifice of the valve takes of the ileum.

IV. Colic: (Fig.XVII.). This form is similar in structure and mechanism to the enteric. A primary colic intussusception is somewhat uncommon, but ileocaecal invaginations are not infrequently complicated by secondary colic folds on their sheath.

They are, as a rule, short, and are found most often in the descending colon.

As regards the relative frequency of the above forms, all statistics agree that the ileocaecal are by far the most numerous. Leichtenstern, who collected records of over 500 cases, gives ileocaecal 44%; enteric 30%; colic 18%; and ileocolic 8%. These percentages were calculated from cases occurring in adults as well as in children, and from both chronic and acute cases. Of 62 cases in children, collected by Holt[1], 74% were ileocaecal; 14% colic; 7% ileocolic; and 5% enteric. These figures are probably a more correct representation of the relative frequency of acute ileocaecal in infants. Of the 50 cases tabulated later, 76% were ileocaecal; 12% mixed enteric and ileocaecal; 6% enteric; 4% colic; and 2% ileocolic. The mixed enteric and ileocaecal referred to is a somewhat interesting variety. An enteric intussusception forms at the lower part of the ileum, and ceases at the ileocaecal valve, which then in its turn becomes the apex of an ileocaecal intussusception which includes the original enteric. It is probable that cases described as ileocolic are not infrequently of this type. Leichtenstern calls this form the

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1. Diseases of Infancy and Childhood.

iliaca-ileo-colica ..... A rare form of intussusception occurs in connection with the appendix, when this structure is turned completely inside out and projects into the lumen of the caecum. Such a condition associated with an ordinary ileocaecal intussusception was reported by Waterhouse[1], and other cases are on record[2] ..... Not quite so uncommon is the intussusception of small intestine into Meckel's Diverticulum. Two cases have been reported recently by Parker and Southall[3]. Watson Cheyne[4] published a case, also recently, in which this condition was associated with a marked congenital stricture of the gut below the Diverticulum. He was able to find references in medical literature to 16 cases of this type ..... The intussusceptions frequently seen in children at autopsies, especially in those who have died of brain disease, are entirely different from the obstructive variety. They are usually multiple, always short, frequently retrograde, and more common in the small intestine than in the large. They show no congestion and the lumen of the bowel is not narrowed. They are easily reduced by very slight traction. They are probably

1. Pathological Society of London, 1897.
2. Ashby "Treatment" No.25th 1897.
3. Lancet, Nov. 12th, 1904.
4. Annals of Surgery, Vol.XL.

caused by irregular and spasmodic intestinal contractions occurring immediately before death.

The pathological changes that take place in an intussuscepted piece of bowel follow one another with alarming rapidity in cases in infants. The intussusceptum becomes strangulated in the intussuscipiens, and the after changes are strictly analogous with those resulting from the strangulation of a piece of bowel in a hernial sac. The mesentery lying between the layers of the intussusceptum, becomes tightly nipped, particularly at the neck (Fig.XI.); the blood supply is thus interfered with, and congestion, oedema, extravasation of blood, and gangrene follow. The rate at which these changes occur varies greatly in different cases. The differences in anatomical arrangement in different individuals doubtless afford a partial explanation of this, but when all is said, we are far from understanding why one patient should be dead in 24 hours from the onset and another under apparently similar circumstances should recover after 48 hours. The complexity of the peritoneal folds included in the mesentery, and the size and consistence of the glands are important factors. The length of the mesentery will also have a considerable effect. When it is short, very strong traction will be made on it be-

fore the tumour has attained a large size with correspondingly great constriction of the included vessels. The opposite state of matters will be found in cases with a long mesentery, other things being equal. Clinical experience supports this theory. Large ileocaecal invaginations which have travelled right round to the descending colon are found to be conparatively little congested, easily reduced, and favourable to the patient. On the other hand, small tumours of the same type confined to the region of the ascending colon are tightly constricted and can only be reduced with great difficulty, if at all. As already pointed out, enteric and ileocolic intussusceptions are of a very acute nature.....The traction of the mesentery has important effects on the shape of the tumour. It causes the intussusception as a whole to assume a curved form with the concavity directed towards the base of the mesentery (Fig.XI.). Passing in between the entering and returning layers the taut mesentery causes the orifice at the neck to be elongated and slit-like, especially on the concave side. Within the sheath, it drags the intussusceptum as a whole towards the mesenteric attachment,so that it is placed eccentrically and not in the same axis as the intussuscipiens. At the apex the mesentery pulls

on the orifice of the intussusceptum, so that it becomes long and narrow instead of circular, and looks towards the mesenteric border of the receiving layer instead of directly down the lumen of the bowel (Fig.XIII.). This pull on the apex may have even more marked results, especially in ileocaecal intussusceptions. On examining specimens of this variety, I have found it to be the rule for the opening of the ileum to be placed quite a considerable distance - sometimes as much as 1½ inches - from the foremost part of the intussusceptum, and to open directly towards the inner wall of the sheath, its position at the apex being taken by much congested and thickened caecum (Figs. XIII., XIV., XV. and XVIII. and Section IV.). Moreover, at operations, it has been frequently noticed that a portion of one of the saccules of the caecum - usually the anterior - has been the last portion of the tumour to reduce, and the last portion to reduce must have formed the true apex. After reduction, too, this portion of the saccule is seen to be dark, much congested, and to have a tendency to dimple in. It suggested itself to one's mind that this saccule might have been the starting point of the invagination, as at first sight it appears that the apex would necessarily be the part first turned in; but

on considering all the anatomical arguments in favour of these intussusceptions starting at the ileocaecal valve, I have come to the conclusion that the traction of the mesentery offers a much more feasible explanation of this phenomenon. The intussusception starts at the valve, and for a time the opening of the ileum certainly forms the apex, but as the mesentery becomes more and more used up and more tightly stretched, the traction on the apex pulls it towards the mesenteric border and the portion of the wall of the caecum furthest from the mesenteric border advances past the opening and takes its place. This is rendered all the more likely by the fact that the caecum must be somewhat folded on itself to allow of its inclusion in the narrower colon, and there will be plenty of its wall to spare for the performance of such an evolution as I have described.

In enteric and colic intussusceptions the traction of the mesentery does not form such a marked feature, doubtless in part at least, because these tumours are usually shorter. In them consequently, the curved outline is not so definite and the opening at the apex looks more or less directly down the lumen of the bowel below.

The changes in the bowel above an acute intussusception are limited to some congestion and dilatation, varying in degree upon the duration of the obstruction. I do not think that perforation at this site has ever been noted in an acute case. In the tumour itself, the intussuscipiens, as a general rule, shows comparatively slight changes. At operations it is frequently seen to be of a slatey grey colour and much wrinkled, and folded on itself as if it were too large for the included intussusceptum. Sometimes it is more deeply congested and of a purplish colour. In enteric forms the sheath presents more congestion and tendency to gangrene than in the ileocaecal, probably because in the former the intussusceptum is more firmly impacted. The pressure of the convex border of the intussusceptum may produce ulceration of the mucous coat of the sheath and even lead to perforation, if the patient lives long enough without relief. As a result of forcible injection of fluid or gas per rectum, the serous coat of the sheath may split, or rupture of the whole wall may even occur.

The changes in the intussusceptum are for practical purposes the only ones of essential importance in acute intussusception. In infants these changes are invariably of an exceedingly acute

character. The intussusceptum is in a state of strangulation, depending upon interference with the vascular supply from the compression of the vessels included in the mesentery at the neck of the tumour. The first results are intense congestion, oedema and extravasation of blood with consequent swelling. These are most marked at the apex and along the convex border of the intussusceptum, because those parts are least compressed, have most room to become distended, and are most remote from the source of blood supply. The neck is as a rule too tightly constricted to show much congestion, and the concave border is tightly compressed by the traction of the mesentery. These points are well seen in any of the diagrams or longitudinal sections. The returning layer, i.e. the layer next the sheath, is generally very much more congested than the central or entering layer; indeed, the latter may even be so compressed as to be smaller than normal, but this is unusual. It seems possible that the arrangement of the mesenteries at the neck of the tumour has something to do with this difference between the two layers. The returning layer is formed by a sharp folding on itself of the sheath at the neck, and the mesentery with its vessels, as well as the bowel wall, will be sharply bent at this spot with conse-

quent compression against the edge of the neck. The mesentery of the entering layer - the direct continuation of the gut above - will lie more in a straight line or gradual curve, and will be subject principally to the annular constriction at the neck to which the returning layer is equally liable (Fig.XII.). These changes commence as soon as the intussusception has occurred, and they rapidly reach their maximum - in almost all cases within 36 hours and in some within 12 hours. Death frequently takes place before any further changes have set in. The haemorrhages into the congested areas may be small and scattered or in the form of large extravasations, splitting up the tissues and forming extensive clots. From the congested mucous surfaces blood escapes and may pass down the bowel and be discharged per rectum. The portions too tightly compressed to show congestion are usually the seat of more serious changes than the engorged parts, and after reduction of the invagination, much haemorrhage and oedema may occur in these areas. There also oedema and degeneration of the muscular fibres are most marked and may have serious results after reduction by causing paralysis of the gut.

If the strangulation persists, gangrene supervenes sooner or later. It is quite impossible to

name a definite time after onset as being that at which gangrene of the intussusceptum will begin. It is usually stated to commence on the 3rd or 4th day; but it may occur much earlier - even within the first 24 hours as some of the cases tabulated later show. It is obviously a question of the acuteness of the process and although one case of a certain type at a certain age may not be gangrenous after three, four or even five days, we must not be surprised should gangrene be found within one day in another case under apparently identical circumstances. In acute intussusception the gangrene rapidly involves the whole intussusceptum, but it appears in most cases to commence at the apex. In some instances, however, gangrene commences at the neck, and Treves[1] states that this is the rule. The returning layer is usually affected earlier, and to a more marked degree than the entering layer. The whole mass may slough and be passed per rectum and should the sheath and entering layer be firmly adherent at the neck, a spontaneous cure may result. Occasionally, for some unexplained reason, the entering layer may slough first and pass down before the returning layer has separated

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1. Intestinal Obstruction. p.169.

turning inside out as it does so by a gradual unfolding at the apex. In such circumstances the cylinder of bowel passed per rectum has its peritoneal covering inside and its mucous surface outside. D'Arcy Power[1] notes that in some cases a process of diffuse suppuration may take the place of gangrene, that in others a fibrous sclerosis of the intussusceptum may occur, and that in a few the intussusceptum may be converted into a mass of reticulin by tryptic digestion; but these terminations must be almost entirely confined to chronic invaginations and may be ignored in connection with acute intussusception ..... Adhesions between the peritoneal surfaces opposed to one another are of very variable occurrence. They form principally between the entering and returning layers because their surfaces are in more or less constant contact. Only after cessation of growth of the intussception can adhesions take place at the neck and the process rarely continues long enough in infants for this to take place to any extent. They are of little importance clinically as they do not become sufficiently organised to be noticeable till the 3rd day, and by this time the condition of an infant is so serious that peritoneal adhesions can hardly make

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1. op. cit.

the outlook more grave ..... The pathology of intussusception, then, may be briefly stated to consist of acute strangulation and obstruction. The obstruction is due to three causes:-

I. The congestion and swelling of the intussusceptum obliterates the lumen of the bowel.

II. The orifice at the distal end is slit-like and narrow from traction of the mesentery and may even, as we have seen, be pressed against the inner wall of the sheath.

III. The whole mass is curved on itself and this will further narrow the lumen of the bowel ..... Irreducibility of an acute intussusception is due principally to the swelling of the intussusceptum. As this is most marked at the apex, it is usually the the last inch or two that cannot be reduced or offer the greatest obstacle to reduction. Twisting of the invaginated bowel in its longitudinal axis may occasionally present a complication, preventing reduction. Excessive swelling of the convexity of the tumour is another cause. Ileocolic intussusceptions are particularly difficult to reduce on account of the unyielding ileocaecal opening through which the intussusceptum has to be passed. Peritoneal adhesions, if present, are usually too soft and recent to offer any serious obstacle to reduction.

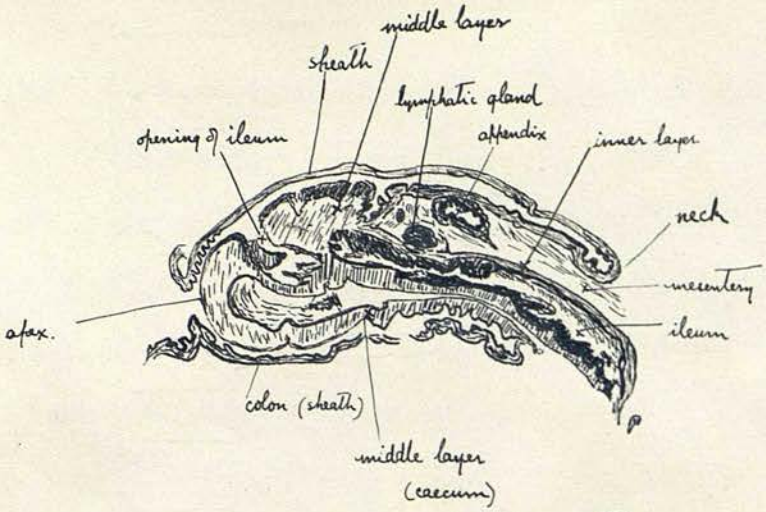
Although much can be learned by a naked eye examination of an intussuscepted piece of bowel, it is only by careful microscopic study that we can determine the exact nature, site and extent of the changes in the tissues. For this purpose, through the kindness of Mr Stiles, I have obtained a complete ileocaecal intussusception of which Mr Richard Muir has prepared most excellent sections. The only authority who has gone into this matter thoroughly is D'Arcy Power[1], and he has paid attention chiefly to the condition of the intussusception as a whole at the different stages. As I have already indicated, gangrene supervenes on congestion at a very varying period of the disease, according to individual circumstances, and the microscope can afford little additional information. Moreover, diffuse suppuration of the intussusceptum or the passage of a slough after a process of fibrous sclerosis or tryptic digestion, which have been so ably discussed by D'Arcy Power, are occurrences of extreme rarity in the acute infantile type. I have, therefore, thought it more important for my purpose to take a typical case at a fairly advanced stage, and to study the relative condition and de-

1. Hunterian Lectures, 1897.

gree of change in the component parts of the tumour.

The sections are cut from a specimen from a male child aged 5 months in whom the intussusception had reached the stage of irreducibility and commencing gangrene in about 35 hours from the onset, and had to be resected. The longitudinal sections (IV., V., VI. and VII. and Fig.XVIII.) are I should think unique. They show very clearly the arrangement of the different layers and the gross pathological changes as well as the microscopical condition. The sheath can be seen to be continuous with the colon at the distal end; and to bend sharply on itself to form the returning layer at the neck. The ileum is seen entering at the neck and terminating at the ileocaecal valve near the apex where it becomes continuous with the returning layer. Half way along is a transverse section of the vermiform appendix. An enlarged lymphatic gland and the remains of the mesentric folds are on the convex side of the tumour beside the appendix. These structures are usually situated along the concavity between the layers of the intussusceptum. The shortness of the tumour and the plane of section probably explain this accidental appearance. What is more important to note is that the layers furthest away from the side of the appendix and mesentery show most swelling ....

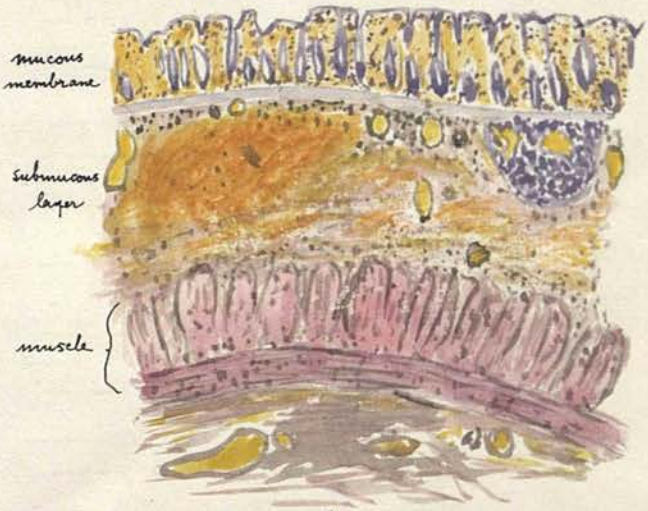
Fig. XVIII



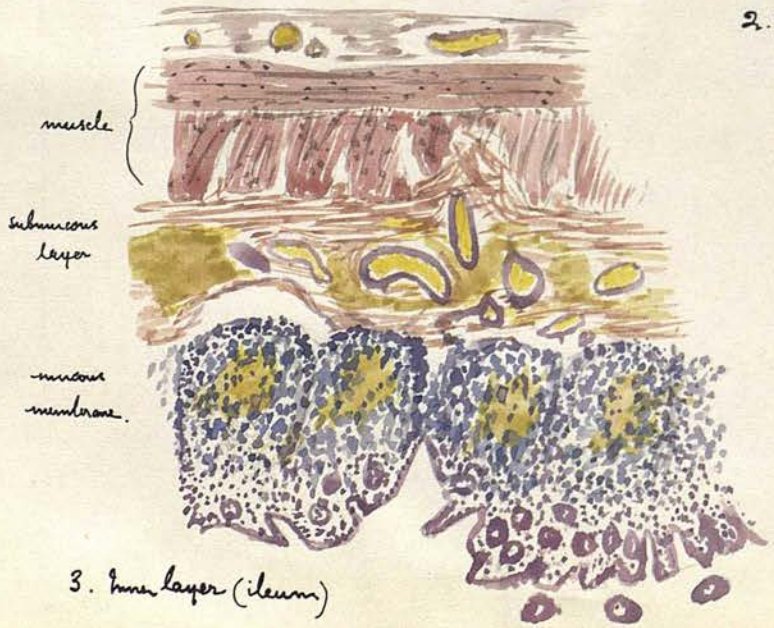
Longitudinal section of Ileocaecal Intussusception

Fig. XIX

1. outer layer. (colon)



2. middle layer (colon or caecum)



3. inner layer (ileum)

Longitudinal Section at Plane I

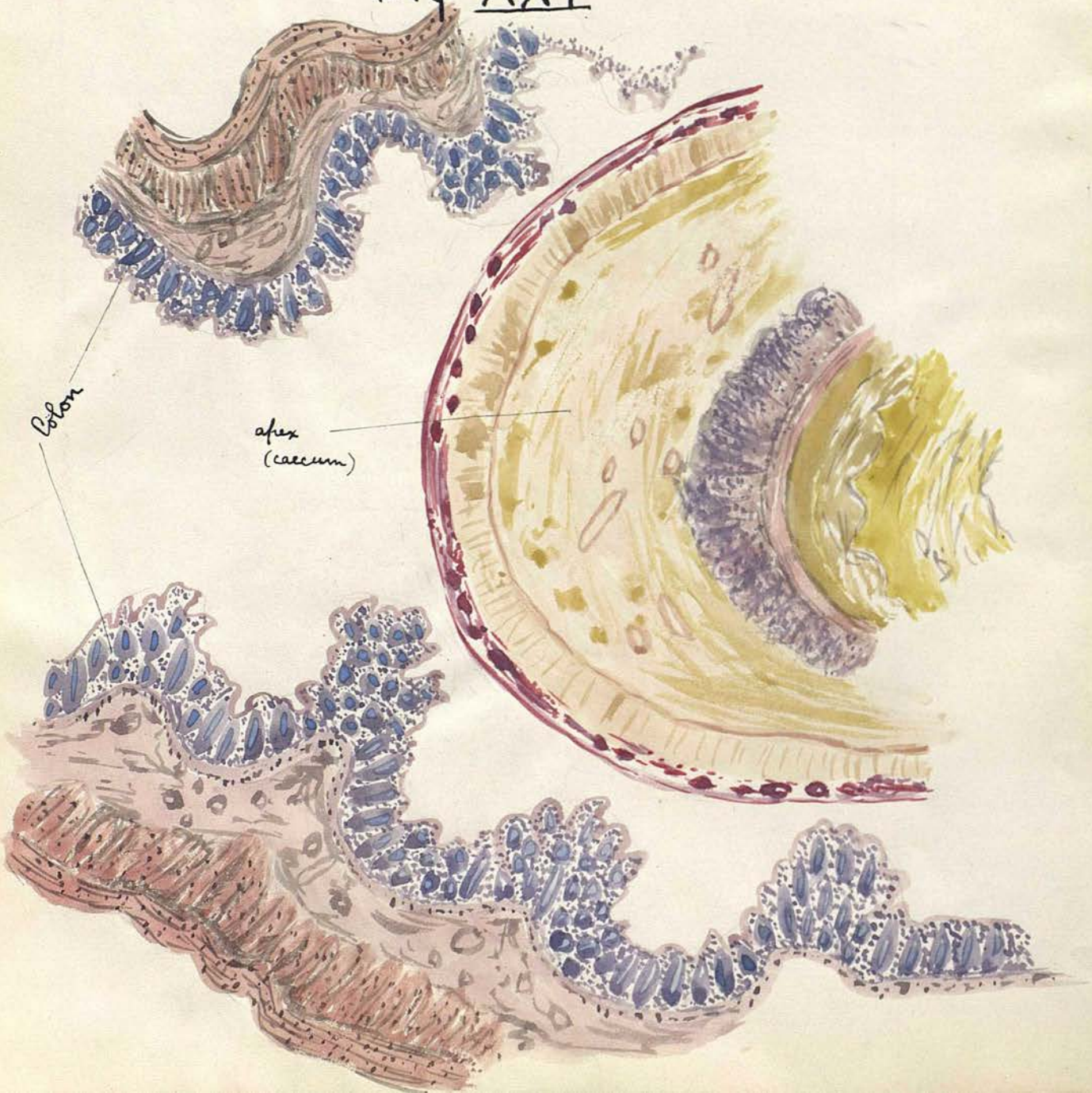
The sheath consists of normal looking large intestine. The returning layer is greatly thickened particularly towards the apex and on the side furthest from the mesentery. The apex itself, composed of caecal wall, is enormously distended, and even with the naked eye it can be seen that the mucous membrane over this part of the bowel is absent. The orifice of the ileum, situated some distance behind the true apex is also greatly engorged. The wall of the appendix is a good deal thickened and beside it is a congested and enlarged lymphatic gland. The walls of the entering layer are greatly thickened, probably more than would be found in the majority of cases, but even here they are less so than those of the middle layer. It can also be seen that there is great lymphatic engorgement beneath the mucous membrane of the entering layer. I propose now to investigate the microscopical condition of the different layers at different parts of this tumour, and for that purpose I have had transverse sections cut at the positions marked by the ink lines in Section V.

Plane I. (Sections VIII. and IX. and Figs. XIX. and XX.).

The outer layer is more damaged than one would have expected from the naked eye appearance. The

Fig. XX

Fig XXI



serous coat and the longitudinal muscular layer are little affected, the fibres of the latter being of good colour and the nuclei well stained. The fibres of the circular muscle on the other hand, are separated by numerous scattered blood extravasations; and the fibres are pale, swollen and with indistinct nuclei. The submucous tissue is oedematous and contains diffuse haemorrhages and a certain amount of small cell infiltration. The vessels, particularly the veins, are distended. The muscularis mucosae is intact. The mucous membrane is in a good state of preservation, but the individual follicles are separated and compressed by extravasations of blood in the reticular tissue. In the follicles the number of goblet cells (containing mucin and stained faint blue) is increased. There is some fibrin exudate and a small amount of blood extravasation in the space between the outer and middle layers .....

The middle layer is more affected than the outer, but not here to such a marked degree as we shall see at the lower planes. The mucous membrane is in a state of commencing distintegration. There is a large amount of haemorrhage in the interfollicular spaces, and the epithelial cells of the crypts are in many places disorganised or absent altogether, particularly on the surface. The muscularis mucosae

is least affected. The submucous layer is much distended and the vessels are congested. In addition to the diffuse haemorrhage throughout the reticular tissue there are large collections of extravasated blood scattered about. The muscular coats show the same changed as were noted in the sheath to a slightly more advanced degree. The peritoneal coat is thickened and shows some cellular infiltration. In the space between the middle and inner layers, i.e. where the mesenteric folds are situated, the veins are greatly engorged and the lymph glands are enlarged as a result of haemorrhages into their substance.

The inner layer (ileum) presents some fibrinous exudation on its peritoneal surface, thickening and infiltration of the peritoneum, and distension of the subperitoneal vessels. The muscular layer is less affected than it was in the sheath and middle layer. There are only a few scattered haemorrhages almost entirely confined to the circular muscle. The submucous tissue is greatly thickened, but there is not so much oedema and the haemorrhages are in the form of small localised extravasations. The vessels are again greatly engorged. The feature of this layer is the condition of the interfollicular lymphoid tissue and the lymph nodes at the base of the mucous

membrane. The core of each villus is packed with small cells and also contains haemorrhages. The mucous membrane as a whole is greatly thickened by the distension of the lymphatic tissue between the crypts and at their base. The lymphoid nodes are greatly distended and their substance is split up by haemorrhages. The muscularis mucosae appears healthy where it can be seen, but it is difficult to trace on account of the lymphatic engorgement. The epithelial cells of the crypts and villi are little affected, but there is a great increase in the number of distended goblet cells. There is no free blood in the lumen of the gut. These changes in the mucous layer are at this level almost entirely confined to the side of the intestine furthest from the position of the mesentery.

Plane II. (Sections X. and XI.).

The sheath and the middle layer are practically the same as those described above. The vermiform appendix is included in this section. Its serous coat is a good deal thickened. The longitudinal muscular layer is in good condition, but the circular fibres show signs of degeneration and are separated by small haemorrhages. The submucous tissue is distended and contains haemorrhages. The mucous layer has great lymphatic engorgement, very much the same

as was noted in the ileum at Plane I. There are also haemorrhages in the lymphatic tissue. Here, as elsewhere, the haemorrhage into the lymph nodes is chiefly situated in the very centre of each nodule.

The inner layer has not been included in the transverse sections, but in the longitudinal ones it can be seen that the thickening at this level is about equal on both sides of the gut. The submucous tissue is more distended than formerly and the haemorrhages are larger. The epithelium lining the crypts is in good condition, but the cells covering the villi are indistinct, granular, and in places quite disintegrated - more especially at the extreme tips of the villi. The lumen of the gut contains fibrinous material, epithelial debris and blood corpuscles. The mesentery in the region of the appendix is much congested. There are haemorrhages in it, and the veins are greatly engorged. The peritoneal surfaces of the layers of the intussusceptum are in close contact, and the fibrinous exudate and small cell infiltration between them indicate commencing adhesions. Close to the appendix (Section VI.) is an enlarged lymphatic gland. Its vessels are much congested and its substance is split up by haemorrhages.

Plane III. (Sections XI. and XII.)

The only differences in the sheath at this level are that the haemorrhages between the crypts in the mucous layer are more extensive, and that the epithelial cells on the surface show some commencing degeneration.

The middle layer is enormously thickened. The mucous membrane is completely disorganised. No epithelial structure is to be seen; its place is taken by a mass of small cells and red blood corpuscles. The muscularis mucosae can still be made out in a fairly good state. The submucous layer consists principally of blood with here and there a few areolar fibres. The state of the muscular coat is as before, but rather more advanced, particularly in the circular layer.

The inner layer is composed of the terminal portion of the ileum. Its peritoneal surface is thickened and between the peritoneum and the muscle there are small blood extravasations. This layer generally is in a much better state than the middle one - practically the same as it was at Plane II.

Plane IV. (Sections XIII. and XIV. Diagram XXI.)

Only the sheath and middle layer come into this section, the latter being formed of caecal wall

folded on itself. The sheath is as before - comparatively healthy, but the caecum is in a condition of gangrene. The mucous membrane is entirely gone and the surface of the bowel is covered merely by fibrin, blood and cellular debris. The muscularis mucosae is disorganised, but a few fibres can still be made out in a wonderful state of preservation. The submucous layer is very wide and is one mass of blood and small cells. The circular muscular layer is much thickened. The haemorrhages in it are not more extensive than formerly, but it is now closely packed with small cells and its fibres in places can hardly be made out. The longitudinal muscle on the other hand has little wrong except a few haemorrhages separating its fibres ..... It may be observed in the longitudinal sections that the epithelium of the ileum right up to its termination is well preserved and that immediately the corner on to the caecum is turned, no mucous membrane can be seen .....

The most important facts to be gathered from the microscopical examination may be summarised briefly as follows:-

1. The slightest effects in all layers are seen at the neck, and the condition becomes gradually worse as we proceed downwards until at the apex

the most advanced changes of all are found - namely, sloughing of the mucous membrane and gangrene. This is contrary to what Treves[1] states to be the rule; but it agrees with the condition found in many cases by D'Arcy Power[2], who refers specially to infantile intussusception which Treves does not.

2. The side of the tumour furthest from the mesentery shows the greatest swelling, but the degenerative changes are equally marked on both sides.

3. In all layers at all positions the submucous tissue is most markedly changed. The mucous membrane comes next, and then, in order, the circular muscular layer, the longitudinal muscle and serous coat, and lastly the muscularis mucosae. From the point of view of the after results the effects on the mucous membrane and circular muscle must be regarded as the most serious. D'Arcy Power lays great stress on the condition of the submucous coat; but from its structure and position one would expect great swelling and this would probably subside and cause no trouble after reduction if the more essential parts of the bowel wall were intact.

4. The middle or returning layer suffers most and the sheath least. The inner layer is much con-

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1."System of Medicine". Clifford Allbutt.
2. Op. cit.

gested and its lymphatic system is engorged; but there are practically no signs of actual disorganisation.

5. The amount of blood extravasation in the mucous membrane is quite sufficient to account for the passage of blood per rectum. The blood probably comes both from the sheath and the middle layer, but principally from the latter .....

Accurate knowledge of these changes cannot fail to be of assistance when we are searching for signs of gangrene etc. at operation: and in guiding us as to which portion of the bowel will require the most delicate manipulative treatment ..... The condition of the circular muscle explains the paralysis of the gut and consequent obstruction that sometimes persist after reduction; and gives one clear indication for after treatment, namely to get the bowels moved as soon as possible.

AETIOLOGY:

Before entering on the clinical part of the subject I wish to sum up shortly what little is known as regards the aetiology of intussusception. It would profit little to enter into a discussion of the many vague and elaborate theories that have been formulated, for although many of them may be in part correct, none can be entirely satisfactory

as it is certain that we have to deal with a disease that has a variety of causes, according to the age of the individual and the portion of the intestine affected. Nothnagel's experiments on animals[1] may be taken to have afforded scientific proof of what has always been a matter of clinical conjecture - namely, that irregular and disordered intestinal contraction is the most important factor in all cases. By stimulating one portion of the intestine and getting it to contract vigorously, he got a temporary slight retrograde invagination above the point of stimulation, and a typical descending intussusception below. The contracted portion passes into the comparatively relaxed part below it, not by virtue of the propulsive power of its own peristalsis - as one is surprised to see sometimes stated, as if the intestine could worm itself along like a snake - but by the action of its longitudinal muscular fibres drawing the relaxed segment over the contracted one for a short distance, after which the relaxed part contracts on the included intussusceptum and moves it along as it would any other foreign body. That such irregular intestinal contraction, produced presumably by digestive disturbances within the bowel or by nervous influences

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1. vide "Intestinal Obstruction", Treves p.172.

acting from a distance, is a factor in all cases may be accepted as indisputable: but with regard to infant life, we have further to explain the overwhelming preponderance of invaginations at one point in the bowel - the ileocaecal junction. I have attempted to show that the anatomical relations of the gut in this region are particularly favourable to the formation of intussusceptions. The points of greatest importance are probably the projection of the ileocaecal valve and the terminal portion of the ileum into the colon; and the mobility of the caecum and colon allowing of commencing invaginations from change of relative position. The influence of individual variations on the occurrence of intussusception, and its extent and variety when it does occur,I have already dealt with. In addition Leichtenstern has pointed out that violent contraction of the terminal portion of the ileum will tend to produce prolapse of the mucous membrane into the colon in the same way as tenesmus and straining produce prolapse of the rectum.

Various exciting causes have been determined in connection with intussusception in adults, and in adults it is the rule to find some definite cause such as a tumour or a polypus. It is the

very opposite with children. The nearest one can get to an exciting cause as a rule is some vague gastro-intestinal disturbance. In some cases the history of such is quite definite - for instance, diarrhoea for some days previous to the attack, or constipation followed by colic; but in others perfect health seems to have existed right up to the onset. In the irritable digestive and nervous systems of children very slight causes may suffice to start spasmodic bowel contraction. Moreover, as Treves[1] suggests, attacks of ordinary infantile colic may actually represent a small bowel invagination which soon resolves. At any rate such colicky attacks are very common in babies, especially if unsuitable food or severe purges have been given; and it is quite possible that the commencement of an intussusception is present during these seizures, although, of course, it is as a rule only when symptoms of strangulation and obstruction ensue that we have an opportunity of seeing the patient. Even if it were otherwise, it is very doubtful if any diagnosis could be attempted. Unsuitable articles of diet, such as raw apples, oranges, etc. are frequently blamed for bringing on an attack, and the

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1. Intestinal Obstruction.

fact that the great majority of cases occur among the poorer classes lends support to such views. Wiggin[1] believes that sudden and violent movements or jolts have a causative effect; and this theory fits in with what I suggested above as regards the mobility of the caecum.

CLINICAL:

I shall now give a full account of the seven cases of acute intussusception that came under my own direct observation.

CASE A.

Male. Age 6 weeks. Admitted 12th November 1903.

History:

On morning of 11th he woke up suddenly with a strange cry, and almost immediately vomited violently. He drew his legs up as if he had severe abdominal pain. During the whole of yesterday the vomiting, pain and crying continued. The pain came at intervals of from quarter to half an hour and lasted for a minute or two. He refused to take the breast at all. The bowels were confined all day until 7 p.m. when he passed about a dessertspoonful

1. Lancet, August 28th 1897.

of bright red blood and some faeces. He passed a restless night, the vomiting and pain continuing as before. At 11 p.m. and 1 a.m. he again passed blood by the bowel in larger quantities and mixed with mucus. He attempted to take the breast once or twice this morning, but vomited immediately. The symptoms continued unabated until admission. Latterly he has been quiet and rather drowsy between the spasms of pain, and seemed much exhausted.

Previous health:

Has had occasional attacks of vomiting after being fed, not accompanied by pain. A right inguinal hernia was noticed when he was 14 days old and it has come down occasionally since.

Family history:

Mother and father healthy. Three other children - one boy is ruptured.

State on admission:

Patient does not seem to be in much pain at present. He is quiet and lies in a drowsy sort of condition with eyes half closed. The face has a drawn collapsed expression, especially round the mouth and the eyes are somewhat dull and sunken. When the abdomen is touched he draws up his legs

and gives a weak short cry. Pulse 140, regular, small and weak. Respirations 40. Temperature 99°. Leucocyte count 17,812 per c.m.....The abdomen is slightly distended, but it is not rigid and it moves freely with respiration. There is visible fulness in left lumbar and iliac regions. On palpation there is a sense of emptiness in the right iliac region and in the left lumbar and iliac regions a hard elongated tumour can be felt more or less vertically placed. On rectal examination one can feel about 2½ inches from the anus a firm rounded projection in the lumen of the bowel. The rectal examination causes great pain and when the finger is withdrawn it is covered with blood.

Operation: 3.30 p.m. 32½ hours after onset of symptoms.

Chloroform was administered and a vertical incision, 2½ inches long was made through the right rectus muscle close to the middle line above the umbilicus. The abdominal cavity was opened in the same line. Coils of distended and congested small intestine escaped and were covered with hot swabs. The intussusception was lifted into the wound. It was of the ileocaecal variety and about 4 inches long. Gentle pressure with the fingers from below

reduced all except the last inch or so. This was covered with a swab and squeezed gently for a minute or two after which reduction was completed by pressure from below. The mesenteries of the small intestine and ascending colon were fixed together with two catgut sutures with a view to preventing recurrence by making the ileum descend towards the caecum. The bowel was douched with hot saline solution and returned to the abdomen. The abdomen was closed by one layer of silkworm gut sutures and the skin edges were united with horsehair.

On return to bed the patient was considerably collapsed. He was surrounded with hot bottles and given two ounces of saline solution and thirty minims of brandy by the rectum. During the first hour his facies and pulse improved rapidly. At 6.30 p.m. he was given thirty minims of Henry's Solution. At 8 p.m. he was greatly better - crying loudly and throwing his limbs about. He was given a small enema and as a result passed flatus. Shortly after, another saline and brandy was administered.

The bowels moved twice during the night and there was no vomiting. Early next morning he was started on small quantities of milk. Thereafter his recovery was uneventful although his convales-

cence was protracted by digestive disorders resulting from the artificial feeding. He was discharged in excellent health on the 5th of December.

CASE B.

Male. Age 6 months. Admitted 23rd November 1903.

History:

Patient was quite well until yesterday afternoon at 4 o'clock, when he suddenly began to scream as if he had severe pain in stomach. In a few minutes he vomited and the vomiting continued almost incessantly for about 15 minutes. During the night he had frequent attacks of pain and screaming and he vomited every time an attempt was made to feed him, as well as at other times. His bowels did not move till 7.40 this morning when he passed a copious loose motion containing a large amount of blood and a little mucus. The bowels have not moved since. The vomiting and pain have continued and he has got rapidly worse.

Previous health:

Good. Has been fed entirely on the breast.

Family history:

Father and mother healthy. No other children.

State on admission:

Well nourished child. Suspiciously quiet. Does not cry unless abdomen is touched. Pale. Mouth drawn. There is a certain amount of collapse. Pulse 140, fairly strong. Respirations 50. Temperature 99·2°. Leucocyte count 18,216: polymorphonuclears 76%.....The abdomen is not distended. It moves freely on respiration. There is no visible tumour. As soon as the hand is laid on the abdomen, the muscles become firmly contracted, and nothing can be palpated. Chloroform was therefore given and then a small elongated tumour could be felt deeply situated in the right hypochondriac and epigastric regions. The tumour was transverse in position and very moveable; nothing could be palpated on examination per rectum.

Operation: 4.30 p.m. 24½ hours after onset.

The abdomen was opened in the middle line by a vertical incision 3 inches long, with its centre at the umbilicus. The small intestine was not congested, and only very slightly distended. The tumour was brought into the wound with difficulty

on account of its deep position. It was found to be a double intussusception, consisting of ileum into ileum starting about 2 inches above the valve, and then of this into caecum with the valve at the apex. The ileocaecal was first reduced with difficulty and then the enteric. There was great swelling and congestion of the gut, and in places it was dark in colour. The intestines were returned to the abdomen and the wound closed.

When put back to bed he was given 4 ounces of saline and a teaspoonful of brandy per rectum. His after progress is interesting, as for more than two days his condition remained critical, and it was impossible to say how things were going to go. Cases of strangulated hernia frequently behave in exactly the same manner when doubtful bowel has been returned to the abdomen. This patient's temperature rose rapidly after operation and at midnight it was 105.6° His pulse was 190 and full in character. Respirations 80. Leucocytes 34,375: polymorphonuclears 89%. He was extremely restless and cried a good deal. His eyes looked glazed and kept jerking upwards in a somewhat ominous manner. The salines and brandy were continued every four hours. He did not sleep at all, and next day, although he was able to take some milk, his pulse was weaker, his

fontanelle depressed, and altogether things looked bad. Three ounces of fluid were injected into the axilla morning and evening. His bowels moved twice but there was more mucus present than faecal matter. He was given Calomel $\frac{1}{6}$ grain every two hours. As the day went on, he seemed to get weaker, and at night he vomited several times. The infusion of saline was continued every six hours. Next day (25th) he was distinctly worse. He was unable to suck and had to be fed with a spoon. His breathing was rapid and shallow and his expression bad. Leucocytes 29,680; polymorphonuclears 81%. Treatment was continued as before. At night he slept quietly for the first time, and next morning he was much better. Leucocytes 10,435: polymorphonuclears 58%. The infusion and enemata were stopped. The calomel was continued and he was given a little brandy by mouth. On the 27th he developed a little bronchitis which retarded his recovery: but otherwise, he steadily improved, and on the 30th his temperature was normal, pulse 128 and respirations 44. He went home on the 9th of December in splendid form.

CASE C.

Male. Age 7 months. Admitted 23rd December 1903.

History:

At 11 p.m. on the night before admission he woke up suddenly, and after whimpering uneasily for a few minutes he began to scream, drew up his legs and kicked, and seemed to have great pain in the belly. A few minutes later he vomited. In about an hour the bowels moved fairly well, but there was blood in the motion. Since then the bowels have not moved.

Attacks of pain and screaming recurred at short intervals throughout the night, and he vomited several times. This morning he took the breast once or twice, but vomited immediately thereafter. He was given some Castor Oil, but vomited this also. The symptoms continued as above until admission.

Previous health:

Entirely satisfactory. Breast fed. No illnesses.

Family history:

Father and mother healthy. Only other child was premature and died shortly after birth.

State on admission:

Fat, well nourished, child. He is quiet and a good deal collapsed. The face is pale and drawn. Pulse 116. Respirations 38. Temperature 99, Leucocytes 18,000, The pulse is regular and of fairly good volume.....The abdomen is only slightly distended and it moves freely with respiration. There is visible fulness to the left of and below the umbilicus, near the middle line. On palpation the abdomen is flaccid. There is emptiness in the right iliac region, and in the umbilical and hypogastric regions to the left of the middle line, there is a hard cylindrical elongated mass placed obliquely with its lower end nearer the mid line than its upper. Per rectum one can feel at the tip of the little finger a firm rounded projection within the bowel. The examining finger is covered with blood.

Operation: 4.30 p.m. 17½ hours after onset.

The abdomen was opened as in the last case. The small intestine was very little distended and not congested. The intussusception when brought into the wound was found to be of the ileocaecal type and about 4½ inches long. Reduction was accomplished by expression from below without difficulty, until the last inch was reached, and this required

careful and patient manipulation. A rounded area about the size of a penny on the antero-external aspect of the caecum was thickened, dark in colour, and dull and roughened on its surface. The intestines were returned and the abdomen closed as before.

There was hardly any collapse after the operation. Six ounces of saline were infused under the skin, and at 7 p.m. three ounces were given by the rectum; at 11 p.m. this latter was repeated and calomel 1/12th grain was ordered to be given two hourly. Milk was given by the mouth at 10 p.m. and at regular intervals thereafter. He made an uninterrupted recovery and was discharged on the 4th of January.

CASE D.

Male. Age 11 months. Admitted 12th January, 1904.

History:

On the 10th of January about 9 a.m. when he awoke he began to cry and draw up his legs as if he had abdominal pain. The pain recurred at intervals all morning, and he refused food. At 3 p.m. he vomited and an hour later his bowels moved. There

was no blood in the motion. The intermittent pain and vomiting continued all night and he did not sleep at all. Two or three normal motions were passed. Yesterday morning the stools were noticed to be of a greenish colour, but otherwise his condition was as before. In the afternoon, dark red blood was noticed in the motions. Since then the bowels have moved four times and every time there has been a considerable amount of blood - latterly of a bright red colour. He did not sleep last night and the attacks of pain and vomiting continued as before.

Previous health:

Good. Breast fed, but lately he has got porridge, soup etc. in addition. No previous illness or intestinal disturbance.

Family history:

Father and mother healthy. One other child - healthy.

State on admission:

Big, sturdy boy. Rather drowsy and apathetic. Face rather pale. Pulse 120, regular and of good volume. Respirations 30. Temperature 97·2°.

The abdomen is a little distended, moves freely with respiration, and there is visible fulness in the left lumbar and iliac regions. Palpation causes pain, but the abdominal wall is not rigid. There is a large cylindrical tumour on the left side of the abdomen, sloping obliquely downwards and inwards from the lumbar into the iliac region. The lower end of the tumour can not be defined. Per rectum a hard rounded projection can be felt about 2 inches from the anus.

Operation: 11 a.m. 50 hours after the onset of symptoms.

The abdomen was opened by a vertical mesial incision about 3 inches long with its upper end about 1 inch above the umbilicus. Some coils of normal small intestine and a few teaspoonfuls of slightly turbid fluid escaped. The intussusception was five inches long and of the ileocaecal variety. The sheath was loose and wrinkled and there were two secondary invaginations of colon into colon. These could hardly be termed intussusceptions, as similar infoldings could be made and unmade without difficulty at any part of the colon. The tumour was reduced with comparative ease. The end of the ileum and the caecum were deeply congested. A

portion of the anterior caecal wall was dark, thickened, and with a tendency to dimple in as in the last case. This was the last part of the tumour to reduce, as it was also in case C.

After the operation the pulse was good and breathing quiet. He was given a saline injection and a teaspoonful of brandy by the bowel. He slept quietly for several hours. The salines and brandy were repeated every 3 hours until next morning. At 8 p.m. a little water was given by the mouth as he seemed thirsty. At 10 p.m. milk feeding was started and also calomel 1/6th grain two hourly. The bowels moved freely next day and his recovery was uneventful. He was discharged on the 30th of January.

CASE E.

Male. Age 3 months. Admitted 23rd February, 1904.

History:

Yesterday morning at 9 o'clock he awoke suddenly, cried loudly and showed signs of pain in stomach. His mother found that he had passed a copious motion streaked with bright red blood. The pain subsided in a minute or two and he was given a feed which he

at once vomited. Throughout the day he kept dropping off to sleep and then starting up with pain and vomiting. He also vomited every time an attempt was made to feed him. On five occasions he passed mucus and blood, but never any quantity of faecal matter. During the night and to-day four more similar motions were passed. He had a fairly quiet night, but during the day the attacks have been more frequent and the mother says that his condition has vecome rapidly more serious.

Previous health:

Breast fed until 2 months old. Since then he has lived on Nestle's Milk, Oat Flour and Allenbury's Food. He has had occasional attacks of vomiting. Two days before the onset of the present illness he was rather constipated and was given a teaspoonful of "Fluid Magnesia".

Family history;

Only child. Father and mother healthy.

State on admission:

Not a very well nourished baby. Distinctly collapsed. Face pale and drawn: eyes sunken and expressionless. Pulse 124, regular, weak and small. Abdomen shows slight general distension. There is

no rigidity. The left side of the abdomen is distinctly full, especially in the upper part. On palpation the right iliac region is markedly empty. A cylindrical sausage-shaped, deeply situated tumour can be felt in the upper part of the abdomen horizontally placed, two thirds of it being to the left of the middle line.

Operation: 9.30 p.m. 36½ hours after onset.

The intussusception - an ileocaecal one, about 3 inches long - was delivered and reduced as in the other cases. No difficulty was experienced except with the last portion. The last part to unfold was again a pouch of caecum, this time on the postero-external aspect. After reduction this portion was seen to be dark, thickened and dimpled in. The lower two inches of the ileum were much congested and thickened. The abdomen was closed as above.

There was considerable collapse after the operation, and five ounces of saline and 15 minims of brandy were infused under the skin of the axilla. By midnight he was much better, and was given water by the mouth. At 4 a.m. on the 24th milk feeding was started; and 1/12th grain calomel given two hourly. The bowels moved in the afternoon. He was discharged on the 12th of March after an uninterrupted recovery, and in much better condition than before the attack.

CASE F.

Male. Age 4 months. Admitted 7th March 1904.

History:

Patient was in good health until 9 a.m. yesterday when he awoke suddenly and began to cry and kick his legs as if he had abdominal pain. His mother have him three teaspoonfuls of castor oil. The attacks of pain recurred about every half hour, but he took the breast well and did not vomit until 1 p.m. After this, the vomiting was severe and frequent. The bowels were confined all day until 8 p.m. when he had a small motion consisting chiefly of blood and mucus. He did not vomit during the night and he slept fairly well, but wakened up frequently screaming with pain. At 6 a.m. to-day he vomited again and has vomited frequently since, especially when attempts were made to feed him. The bowels did not move again till 7 a.m. when he again passed blood and mucus. At 2 p.m. this was repeated. He has been quiet and drowsy all day except for the attacks of pain.

Previous health:

Has had one or two slight attacks of bronchitis Breast fed, and has had bread and milk in addition lately.

Family history:

Father and mother healthy. Four other children healthy. One child still-born.

State on admission:

Rather a delicate looking child. Prominent veins on head. Curious long shaped head and narrow forehead. Very much collapsed. Quiet. Pale. Lips livid. Eyes glazed. Does not seem fully conscious. Pulse 130, almost imperceptible. Respirations 48, shallow. Temperature 97·6. Shortly after admission he vomited some dark coffee grounds material.....Abdomen somewhat distended, but not rigid. A hard elongated tumour can be felt deeply placed under the right costal margin, running obliquely from below upwards and to the left. Nothing can be made out per rectum.

Before operation 2½ ounces of saline along with 10 minims of brandy and 1/200th grain of strychnine were infused under the axilla.

Operation: 7.30 p.m. 34½ hours after onset.

On opening the abdomen, distended coils of small intestine and a much distended stomach escaped. The invagination was ileocaecal and about 3½ inches long. The last portion was extremely badly nipped and was reduced with great difficulty. The caecal pouches were reduced last and they were very dark

and thickened. The antero-external one particularly was quite black and it was inverted by means of fine Lambert silk sutures. There was a rent in the peritoneum covering the caecum and this was closed with silk sutures. It was found impossible to return the distended stomach and intestines to the abdomen. The stomach was, therefore, punctured with a trocar and gas allowed to escape. The puncture hole was then closed with silk. Even then the viscera were only returned with great difficulty. 1/200th grain strychnine was given during the operation.

On return to bed the patient was extremely collapsed. Pulse inperceptible. He vomited a large quantity of dark brown fluid. Six ounces of saline + 20 minims of brandy and 1/200th grain strychnine were infused. He improved a little after this but the vomiting continued. His stomach was therefore washed out and the vomiting then ceased. After midnight he became steadily weaker and died at 3 a.m. No post-mortem examination was allowed.

Case G.

Male. Age 2 years and 9 months. Admitted 21st March 1904.

History:

On the 19th March he ate an orange and the following day it was noticed that he had passed undigested pieces of orange. Otherwise he was quite well. This morning he took a good breakfast. At 10 a.m., while playing outside, he was suddenly seized with severe pain across the bowels, vomited violently, and turned very pale. He was put to bed and given half an ounce of castor oil which he promptly vomited. At 11 a.m. he was given a water enema which was returned unaltered. The pain and vomiting continued. Half an hour later another enema was given and this time some blood was passed. Since then he has had one motion consisting of blood and mucus. During the last four hours the symptoms have been less severe and he has slept a good deal. He has not been fed all day.

Previous health:

Good. Had whooping cough two months ago.

Family history:

Father and mother healthy. Nine other children all healthy. One boy was ruptured as an infant.

One girl died of tuberculosis,aged 15 years.

State on admission:

Healthy looking, well nourished boy. Quiet and rather drowsy. Good colour. Practically no collapse. Pulse strong and steady 120. Respirations 28. Temperature 99°.

Abdomen moves freely and is not distended or rigid. There is distinct fulness on the right side above the umbilicus. A small elongated tumour can be felt in this region, almost parallel with the costal margin. It is moveable, but not hard or well defined. Some distance below this in the right iliac region a smaller round hard mass can be felt. Nothing can be palpated per rectum and there is no blood on the finger when it is withdrawn.

Operation: 8.30 p.m. 10½ hours after onset.

A short ileocaecal intussusception about 2 inches long was found in the position of the upper tumour. It was very easily reduced. The appendix was long and hard at the tip. It was removed. A mass of enlarged glands was found in the enteric mesentery in the position of the lower tumour.

There was no collapse and no sickness after the operation. No stimulants were given. At 4 a.m. on the 22nd milk feeding was commenced. 1/6th grain calomel two hourly given. At 8 p.m. he was

rather restless and as the bowels had not moved 1/200th grain strychnine was given hypodermically. At 1 a.m. on the 23rd this was repeated and an hour later the bowels moved - a copious motion, foul and mixed with mucus. As the day went on he got worse and towards evening his pulse and breathing became rapid and his temperature rose. As nothing could be found in the lungs to account for this, I opened the wound and explored the abdomen with my finger. Apart from some thickening in the region of the caecum, nothing could be felt. A gauze drain was put in. The foul slimy stools persisted for a day or two, and the temperature rose to 105° the next evening, but after that he improved steadily. The wound healed well and he was discharged on the 16th of April.

As I have written these cases fully out, it will hardly be necessary to give a detailed account of the other 43 cases of intussusception at the Children's Hospital, of which I have obtained records. I have merely tabulated the chief points of interest of all the cases, including the above seven.

One or two of the cases recorded are over two years of age, and therefore could not properly be called infants. The disease in these cases, how-

ever, was of the acute type, and I think it would have been a pity to omit them. The cases are numbered for convenience in reference. The date in the second column is the day on which operation was performed. The figures under "Duration" represent the number of hours between the onset of symptoms and the operation. The time of survival after operation is given in hours. "Previous disturbances" means gastro-intestinal disorders immediately preceding the attack.

The following contractions are used:-

M. = Male,
F. = Female,
I.c. = Ileocaecal,
E. = Enteric (Under "Type").
C. = Colic,
R. = Right,
L. = Left,
L.L. = Left Lumbar,
R.L. = Right Lumbar,
I. = Iliac,
U. = Umbilical,
H. = Hypogastric,
L.H. = Left Hypochondriac,
R.H. = Right Hypochondriac,
E. = Epigastric (Under "Position"),
Lap. = Laparotomy,
Res. = Resection of bowel,
D. = Death,
R. = Recovery.

No.	Date	Age	Sex	Duration.	Type	Passage of Blood	Palpable per rectum	Position of abdominal tumour.	Treatment	Time of survival	Previous disturbances.	Result	Remarks.
1.	7.3.98	4/12	M.	46	I.C.	+	+	L.L: L.I.	Lap.	10	-	D.	
2.	18.5.99	5/12	M.	52	I.C.	+	-	R.I.	Lap.	12	-	D.	
3.	18.6.99	5/12	M.	12	I.C.	+	+	L.I.	Lap.	44	+	D.	Attack of pain, vomiting, and passage of blood 5 days previous. Recovery without treatment.
4.	28.9.99	3/12	M.	24	I.C.	+	-	R.I.	Lap.	R.	+	R.	Found to have reduced itself by time abdomen was opened.
5.	19.10.99	5/12	M.	19	I.C.	+	+	L.L.	Lap.	R.	+	R.	Diarrhoea for a week before onset.
6.	23.4.00	6/12	M.	41	I.C.	+	-	L.I.	Lap.	12	-	D.	Temperature 107° at death.
7.	12.12.00	9/12	M.	3½	E:I.C.	+	-	R.L: U: E.	Lap.	10	+	D.	P.M. Gangrene of ileum
8.	24.11.00	6/12	M.	22	I.C.	+	-	L.I.	Lap.	R.	+	R.	Had faecal vomiting.

No.	Date	Age	Sex	Duration.	Type	Passage of blood	Palpable per rectum	Position of abdominal tumour.	Treatment	Time of survival	Previous disturbances.	Result	Remarks.
9.	1.3.01	6/12	F.	18	I.C.	+	+	L.I: L.L.	Lap.	6	+	D.	Vomited coffee grounds material after operation.
10.	26.3.01	4/12	M.	50	I.C.	+	+	L.I.	Lap. Res.	2	-	D.	Intussusceptum gangrenous.
11.	6.6.01	2 6/12	F.	96	E: I.C.	+	?	?	Lap. Res.	7	+	D.	Had whooping cough.
12.	7.7.01	4/12	M.	24	I.C.	+	-	E	Lap. Res.	144	+	D.	P.M. Peritonitis
13.	1.11.01	3/12	M.	24	E	+	+	R.I.	Lap. Res.	0	+	D.	Intussusception a few inches above ileocaecal valve. Gangrene
14.	6.2.02	1 6/12	F.	?	Double E.	+	-	R.L.	Lap. Res.	16	-	D.	First onset of symptoms 12 days before admission Relief and apparent recovery by injection on 5th and 10th days.
15.	9.6.02	5/12	M.	48	I.C.	+	-	?	Lap.	4	+	D.	Had bronchitis.
16.	30.6.02	1 9/12	M.	40	I.C.	+	+	L.I.	Lap. Res.	16	-	D.	Pauls Tubes used
17.	4.8.02	4/12	M.	2½	I.C.	+	-	E.	Lap.	R.	-	R.	

No.	Date	Age	Sex	Duration.	Type	Passage of blood	Palpable per rectum	Position of abdominal tumour	Treatment	Time of survival	Previous disturbances.	Result	Remarks.
18.	15.8.02	9/12	F.	33	I.C.	+	+	L.I.	Lap.	9	+	D.	Gangrene. Tumour fixed outside abdomen.
19.	2.10.02	5/12	F.	53	I.C.	+	+	U: L.L.	Lap. Res.	11	-	D.	Gangrene of intussusceptum.
20.	20.10.02	Y	F.	72	E.	-	?	R.L. R.I.	Lap. Res.	72	+	D.	History of prolapsus ani.
21.	7.11.02	5/12	M.	35	I.C.	+	?	R.L.	Lap. Res.	7	+	D.	
22.	21.11.02	10/12	M.	7½	I.C.	+	?	R.L: U.	Lap.	R	+	R.	Appendicectomy.
23.	3.12.02	4/12	M.	48	I.C:C.	+	+	L.L:L.I.	Lap.	4	+	D.	Secondary invagination of sheath 3 inches long at splenic flexure.
24.	20.1.03	5/12	M.	70	I.C.	+	+	L.L:L.I.	Lap.	5½	-	D.	
25.	30.1.03	11/12	M.	36	C.	+	+	L.L:L.I.	Lap. Res.	12	+	D.	10 inches of transverse and descending colon resected.
26.	10.2.03	3	F.	15	I.C.	+	+	L.I.	Lap.	12	+	D.	Appendicectomy.
27.	16.2.03	4/12	M.	16	I.C.	+	+	R.I.	Lap.	51	-	D.	Appendicectomy.
28.	21.2.03	6/12	F.	11	E:I.C.	+	+	R.L:E.	Lap.	14½	-	D.	Enteric intussusception a few inches above valve.

No.	Date	Age	Sex	Duration.	Type	Passage of blood	Palpable per rectum	Position of abdominal tumour	Treatment	Time of survival	Previous disturbances.	Result	Remarks
29.	4.7.03	9/12	M.	15	I.C.	+	+	L.L: L.I.	Lap. Lateral Anastomosis	3	+	D	Irreducible. Tumour left attached outside abdomen.
30.	15.8.03	11/12	F.	22	I.C.	+	+	L.L: L.I.	Lap. Res.	10	+	D.	P.M. Peritonitis
31.	1.9.03	11/12	M.	?	I.C.	+	+	L.I.	Lap. Res.	?	-	D.	
32.	12.11.03	1½/12	M.	32½	I.C.	+	+	L.I.	Lap.	R	+	R.	Case A.
33.	23.11.03	6/12	M.	24½	E:I.C.	+	-	R.H: E.	Lap.	R	-	R.	Case B.
34.	23.12.03	4/12	M.	17½	I.C.	+	+	U: H:	Lap.	R	-	R.	Case C.
35.	12.1.04	11/12	M.	50	I.C.	+	+	L.L: L.I.	Lap.	R	-	R.	Case D.
36.	23.2.04	3/12	M.	36½	I.C.	+	-	E.	Lap.	R	+	R.	Case E.
37.	7.3.04	4/12	M	34½	I.C.	+	-	L.H: E.	Lap.	7½	-	D.	Case F. Moribund on admission.
38.	21.3.04	2 9/12	M.	10½	I.C.	+	-	U: R.H.	Lap.	R	+	R.	Case G. Appendicectomy.
39.	21.4.04	11/12	M.	6	I.C.	+	+	U: R.H.: R.L.	Lap.	R	-	R.	Appendicectomy.
40.	22.4.04	5/12	F.	10	I.Colic	+	+	U: R.H.	Lap.	R.	-	R.	
41.	6.5.04	6/12	M.	20	I.C.	+	+	L.L: L.I.	Lap.	R.	+	R.	
42.	4.7.04	4/12	M.	36	I.C.	+	+	L.L: L.I.	Lap.	12	-	D.	

No.	Date	Age	Sex	Duration.	Type	Passage of blood	Palpable per rectum	Position of abdominal tumour.	Treatment	Time of survival	Previous disturbances.	Result	Remarks.
43.	15.10.04	6/12	M.	7½	C.	+	-	R.I.	Lap.	R.	-	R.	Double colic intussusception.
44.	19.11.04	6/12	M.	28	I.C.	+	-	R.L: U.	Lap.	R.	-	R.	
45.	28.12.04	6/12	M.	26	I.C.	+	+	L.L: L.I.	Lap.	R.	-	R.	Ventral hernia ensued and was treated successfully by operation.
46.	13.1.05	4/12	F.	25	I.C.	+	-	U: R.L.	Lap.	R.	-	R.	
47.	13.2.05	4/12	M.	18	I.C.	+	-	L.L.	Lap.	R.	-	R.	Appendicectomy. Sheath here and there was slightly folded on itself.
48.	12.12.04	9/12	M.	7	E:I.C.	+	-	U: R.H. R.L.	Lap.	R.	-	R.	
49.	11.2.05	11/12	M.	9	E:I.C.	-	-	U: R.H. R.L.	Lap.	R.	-	R.	Same patient as No. 48.
50.	6.3.05	4/12	M.	40	I.C.	+	-	R.L.	Lap.	R.	-	R.	Appendicectomy.

One point of interest is not brought out by these tables, namely, that most of the patients were healthy, well-nourished infants, and this seems to be the general rule in intussusception. In only three cases was there any hint that the child was delicate or ill nourished, and in the great majority it was distinctly stated he was the very opposite. 78% of the cases were in boys, and only 22% in girls - too large a preponderance of males to be merely accidental. As regards age, the youngest was an infant of six weeks. Only four cases were over two years. Their ages were $2\frac{6}{12}$; $2\frac{9}{12}$; 3; and 7 years respectively. 8% were under 4 months of age: 62% between 4 and 7 months inclusive; 18% between 8 and 12 months inclusive; 4% between 1 and 2 years; and 8% over 2 years. The case mortality at the different ages was as follows:- Under 4 months 25%; between 4 and 7 months, 58%; between 7 and 12 months 44%; between 1 and 2 years 100%; and over 2 years 75%. 66% of the cases occurred between October and March. The greater frequency in winter has been attributed to cold and also to the fact that, during these months, festivities are commoner, at which the youngest member of the family is given rich and indigestible foods for the first time in his life with consequent intestinal irritation. The total

recoveries formed 44% and the deaths 56%. In all the cases in which resection of a portion of the bowel was found necessary, death ensued. These formed 28% of the total number. Of the 72% in which it was not necessary, a little over 61% recovered. The time elapsed between the onset of symptoms and the operation is a matter of great interest. In the recoveries it averaged 20 hours; in the deaths 37 hours (one not stated). Of those operated on within 24 hours of the onset 60% recovered; of those done after the first day 29% recovered. The successful case with the longest duration was No.35 (50 hours), and it is just possible that in this case the symptoms of the first day or so were due to some intestinal irritation and colic which culminated in an intussusception.

Of 22 cases that recovered:-

7	were	operated	on	within	10 hours,
10	"	"	"	"	18 "
15	"	"	"	"	24 "
20	"	"	"	"	36 "
2	"	"	"	after	36 ".

Of 27 cases that died:-

1	was	operated	on	within	10 hours
7	were	"	"	"	18 "
11	"	"	"	"	24 "
15	"	"	"	"	36 "
12	"	"	"	after	36 "

As stated above, the ileocaecal form is by far the most common, 68% being of this variety. Of

these 47% recovered. The mixed enteric and ileo-caecal formed 12% with 40% recoveries. 6% were enteric and of these none recovered. The colic formed 4% with the same number of deaths as recoveries. The ileocolic contributed 2% with no deaths.

I will refer later to the other points noted in the tables.

SYMPTOMS:(1)

The symptoms of acute intussusception are remarkably constant and characteristic. The history of one case differs little from that of another, and as in no other disease is there a similar chain of symptoms, we can, as a rule, make a tolerably accurate guess at the nature of the condition present from the history alone. The onset is almost invariably extremely sudden. It is true that the child may have been out of sorts for a day or two; there may have been some diarrhoea, vomiting, or other signs of gastro-intestinal upset. In 46% there was a history of such disturbance more or less immediately antecedent to the onset of symptoms. But even in these cases there is generally an absolutely definite history of a sudden seizure. The mother has no hesitation in stating the exact time at which the ilness commenced, and what it was that

1. The typical symptoms are very vividly described by John Hunter in his paper on "Introsusception".

occurred first. The first symptom in the great majority of cases is pain - sudden severe abdominal pain accompanied by screaming, drawing up of the legs, and kicking. It apparently comes on at any time of the day, and with no particular relation to food. The child may waken screaming from a peaceful sleep, or he may suddenly cry out while being fed or while lying quietly in his cradle. In other cases restlessness, irritability and peevishness are observed for some hours before the pain begins; and vomiting may sometimes be the first symptom; but it is more than likely that these symptoms accompany the pathological condition which precedes the formation of the invagination, and that in most instances the pain indicates the commencement of the disease itself. Passage of blood by the bowel very rarely occurs before the onset of other definite symptoms. In 37 of the above cases I have found careful notes of the exact mode of onset. In 30 of these it was sudden; in only 7 was it more or less gradual, or at any rate was not of the nature of a sudden violent seizure. In 22 of the 37 severe pain was the first thing noticed. In 8 vomiting was the first symptom. In 6 restlessness or general uneasiness drew attention to the fact that the child was not well before the more severe symptoms appeared. In only one did passage of

blood precede pain and vomiting, and in this case severe diarrhoea had been present for some hours before the blood was observed, and it was of small quantity, so that is presence could be accounted for, apart altogether from intussusception. A sudden spasm of pain, then, is the commonest mode of commencement, and generally speaking, intermittent pain continues till the patient becomes moribund. The pain appears to be of a colicky nature, is short in duration, and is followed by a quiet interval during which the patient is in comparative comfort until the next seizure occurs. The frequency of the attacks varies, and it is difficult to get exact data on this point. In some cases they seem to come every few minutes. In others the baby will be said to have slept uninterruptedly for several hours before being wakened up by another spasm. After a varying period - usually from between 24 to 36 hours, but frequently longer - the pain gradually ceases and the patient becomes quiet and drowsy. This often leads the relatives to suppose that the attack is passing off, and that merely exhaustion remains, whereas it is one of the gravest symptoms and usually indicative of paralysis of the gut or commencing gangrene. Vomiting usually comes second in the sequence of symptoms. Almost immediately

after the onset of the pain the child vomits violently and repeatedly, and probably soon evacuates all the contents of his stomach. Thereafter only small quantities of yellowish fluid are brought up; or the symptom may cease altogether, except when attempts are made to administer food or purgatives. In only one case, (No.8) , have I been able to find stercoraceous vomiting noted.

The third and most characteristic symptom is the passage of blood or blood-stained mucus by the bowel. This is practically constant; in only 2 of the 50 cases was it absent. One of these was an enteric intussusception, and the other was a mixed enteric and ileocaecal. The latter was operated on very promptly as it was the second time that the patient has suffered from the condition (No.49). On the first occasion blood was passed, and it probably would have been on the second, had relief not been obtained so soon. The passage of blood frequently occurs at the same time as an attack of pain and is often accompanied by a good deal of straining. Blood does not usually appear until after the first 4 or 5 hours, but the time of onset of this symptom varies within wide limits according doubtless to the position and state of congestion of the tumour.

In most cases there is some diarrhoea before absolute constipation sets in as a result of the obstruction caused by the tumour. The diarrhoea is due to the violent peristalsis set up by the intussusception. The bowel below empties itself, and there is probably also a good deal of faecal matter passed along the lumen of the intussusceptum in the very early stages before occlusion takes place. After this preliminary diarrhoea, which may consist of one large motion or several small ones, nothing is, as a rule, passed but small quantities of mucus and blood. In case No.46 - a typical ileocaecal invagination with marked congestion- a normal motion was passed about half-an-hour before operation. I can offer no satisfactory explanation of this phenomenon, but such an occurrence would be very misleading in a case in which diagnosis was doubtful. Fortunately it is very rare.

Usually the child refuses the breast and will not take anything by the mouth. Sometimes, however, the natural instinct seems to be too strong and he will suck as often as he is allowed - only to vomit immediately after swallowing.

Lastly one should note that the general condition of the patient rapidly becomes a very serious one. Collapse appears in some cases alarmingly early, and is soon followed by a sinking into a

moribund condition. In this connection it is of great value to ask the mother her opinion of the baby's condition. Infants vary so much in their appearance, facial expression and general attitude that it is often difficult to estimate accurately the extent of the collapse; but the mother who knows so well what the child's demeanour is in health will usually be found to be correct, is she states that he is"very ill" or "awfully felled".

PHYSICAL SIGNS:

The physical examination of a patient suffering from severe colic,vomiting, etc. must always be performed with the very greatest care, for a superficial inspection might easily result in an early intussusception being overlooked.

In most cases the child is quiet, perhaps sleeping, and when roused does not cry, or if he does, the cry is weak and unnatural. At intervals he may scream and draw up his legs. The general appearance is misleading to one who has not made a study of infants. A casual observer might think that there was little the matter. But on more careful examination, this very quietness is seen to be due to a more or less serious state of collapse. I have gone through the 50 cases in the Children's

Hospital and noted the varying degrees of collapse in the different patients on admission. In 26 only a slight amount was present; of these 14 recovered and 12 died. In 20 the collapse was fairly severe; of these 7 recovered and 13 died. And in 4 the patient was extremely collapsed; of these 1 recovered and 3 died. The complexion is generally pale, perhaps of a somewhat earthy tint, and the face is drawn, particularly round the mouth. The eyes are sunken, and in bad cases dull and expressionless. Depression of the fontanelle is only present in severe and advanced cases. The respirations are a little quickened and the pulse rapid. The state of the temperature depends on the stage that has been reached. Within the first 24 to 36 hours, it will usually be subnormal or normal, as one would expect in association with collapse. Later, when gangrene and inflammatory mischief set in, it is usual for the temperature to rise 2 or 3 degrees. In infants the temperature is subject to large and rapid fluctuations from slight causes, and here, as in other diseases, one cannot draw accurate conclusions from this sign alone. Of the 50 cases 4 had a temperature on admission of over 102° and they all died. Three of them had a history of over two days duration; the fourth had only existed for

15 hours, but the tumour was intensely congested and quite irreducible. Seventeen had a temperature between 100° and 102°. Six of these recovered and 11 died, and of the latter 7 cases were irreducible or gangrenous. In 25 the temperature was between 98° and 100°, of which 14 recovered and 11 died. The 4 remaining were below 98° and 2 of them recovered.

The abdomen in most cases is only moderately distended, and moves freely with respiration. Great distension, tenseness and rigidity are hardly ever seen. A certain degree of asymmetry may be visible. For example, the left side of the abdomen may be full, with a corresponding depression on the right side. Lastly, a definite elongated tumour may be visible in one or other region of the abdomen ..... Palpation often causes great pain, with consequent rigidity of the abdominal wall, and on this account chloroform may have to be administered before the presence or absence of a tumour can be made quite certain. When the tumour is felt, it can be made out to be firm, cylindrical and elongated, with varying degrees of size and mobility. Usually it is slightly curved in its long axis, and this renders the term "sausage-shaped" peculiarly applicable ....

The position of the tumour is a point of some interest. In 48 of the 50 cases the position was definitely stated. In 3 it was in the upper part of the abdomen; in 20 on the right side and in 25 on the left side. Taking the different varieties separately, the positions were as follows:-

	Right.	Left.	Top .
Ileocaecal	12	23	2
Enteric	3	0	0
Mixed	4	0	1
Colic	1	1	0
Ileocolic	1	0	0

The positions in the ileocaecal cases that recovered and those that died are worth mentioning, because the situation of the tumour indicates the length that it has travelled. Of the 17 that recovered 9 were on the right or upper part of the abdomen, and 8 on the left side. Of the 21 that died, 4 were on the right or upper part, 16 on the left, and 1 was not stated ..... The "signe de Dance", or emptiness of the right iliac region in ileocaecal intussusceptions, is certainly unreliable and may be absent; but it is not, as is frequently

stated, entirely the product of powerful imagination on the part of those who would make fact fit theory. In 3 of my 7 cases it was quite definitely present, and I noted it in my first case without knowing that it was a sign to be looked for and without having thought of the position of the invagination ..... Lastly, on examining the rectum the apex of the intussusceptum can often be felt in cases where the tumour has travelled far enough; and in others the tumour can sometimes be palpated through the wall of the bowel. Out of 46 cases in which an examination was made the tumour was palpable per rectum in 26 and not in 20. As regards the character of the apex, when it is felt it is probable that here imagination plays a very large part. From textbook descriptions one would gather that the "os uteri" form was almost invariable - a rounded projection in the lumen of the bowel with a dimple in the centre corresponding to the ileocaecal valve. Personally I have never been able to satisfy myself that I felt anything more than a simple rounded projection; and the actual position of the ileocaecal valve, as I have described it above, confirms my belief that only very rarely, if at all, could one palpate the opening per rectum ..... The examining finger on being withdrawn is frequently seen to be covered

with blood ..... Occasionally the intussusceptum may actually protrude from the anus. When this occurs, there is generally a great deal of tenesmus. In none of the 50 cases was this sign present. Wiggin[1] found it in 5% of his 103 cases.

DIAGNOSIS.

The diagnosis of acute intussusception is in the majority of cases comparatively simple, but in spite of this, it is a frequent experience in hospital to have cases sent in too late either with no diagnosis at all, or with a statement to the effect that treatment for colic having been employed with only temporary benefit, intussusception was feared. Of late years more attention has been drawn to the condition as occurring in infants, and a steadily increasing number of cases is recorded as time goes on. This is probably due to the fact that fewer cases are missed and not to any increase in the prevalence of the disease..... Sudden severe pain in the abdomen soon followed by vomiting, especially occurring in a child about 6 months old, should at once raise the question of intussusception in our minds; and it should only be excluded after the most careful abdominal examination. Passage of blood by the bowel makes the diagnosis almost

1. Lancet. August 28th 1897.

certain if associated with the other symptoms, but we need not wait for the occurrence of this before making up our minds. The general state of the patient gives valuable help: and we can judge of this better if we have full knowledge of the child's previous condition, for which reason the family doctor can in most cases greatly assist the surgeon by giving his opinion on this point. All doubt is removed when the projecting apex can be felt per rectum..... Should the condition be overlooked and palliative treatment resorted to, the child's fate is in all probability sealed, and I cannot emphasise too strongly the importance of early diagnosis. If there is the slightest uncertainty - and considerable doubt must often exist, particularly in the early stages - an examination under chlorofotm should be made at once. Before collapse has set in the infant will probably strongly resent abdominal palpation: and as we usually have to deal with healthy well developed babies, it may be impossible to exclude the presence of an abdominal tumour on account of the voluntary fixation of the muscles.

A good plan is to place the flat of the hand quietly but firmly on the abdomen and wait for the termination of a fit of crying when the muscles will be suddenly relaxed allowing of a thorough, if very

brief examination. If still no tumour can be felt, chloroform should be given without hesitation. Infants take chloroform well; they go under with a small dose; and as only a momentary anaesthesia is required, no bad effect is likely to result. In two of my seven cases I was not able to feel a tumour at all until the anaesthetic had been given. One must not forget while examining the abdomen that the intussusception may be small and deeply situated, and that even under chloroform, its detection is often difficult, especially when it is placed deeply in the iliac region or in the hypogastric region under cover of the liver. A free rectal examination should be made at the same time, for this causes a good deal of pain when performed without an anaesthetic and the straining renders difficult an exact localisation of what is felt ..... The differential diagnosis is chiefly concerned with those diseases associated with the passage of blood by the bowel.

1. A severe ileocolitis with diarrhoea and tenesmus may cause blood and mucus to appear in the stools. Apart from the history of a sudden onset with severe pain and the presence of an abdominal tumour there is vomiting and a normal or subnormal temperature in intussusception while in ileocolitis

the temperature is high and vomiting usually absent.

2. Any form of diarrhoea, especially if there is ulceration of the bowel, may be associated with blood in the motions, but here the history and general condition are entirely different. In the ordinary diarrhoea of infants, there is usually bile in the motions and this is never found in intussusception.

3. Rectal polypus usually causes more copious bleeding than does intussusception; and an examination of the abdomen and rectum clear up the diagnosis. An infant was sent to the Children's Hospital last winter suffering from tenesmus and passage of blood, with a diagnosis of intussusception. On careful examination no tumour could be found and the removal of a rectal polypus with a pair of dressing forceps resulted in instant relief.

4. Congenital obliteration of the bile ducts or serious organic disease of the liver may lead to the discharge of blood from the bowel; but these conditions are hardly likely to be mistaken for intussusception.

5. Cases of purpura haemorrhagica have sometimes been diagnosed and treated as intussusception, probably because the passage of blood has been so much emphasised as a symptom of the latter to the neglect

of the more important signs and symptoms.

COURSE AND PROGNOSIS.

When an acute intussusception has formed, its course depends principally on the tightness with which the bowel is nipped and the acuteness of the congestion. In what are termed the ultra-acute cases, the child dies within 24 hours - sometimes as soon as 10 hours after the onset. Others live for 48 hours or three days with acute symptoms. In a few cases in which the course is not so exceedingly acute, the patient may survive for several days. Among some cases collected by Lawford Knaggs[1] is one recorded by Marsh of a male child aged 7 months who was operated on successfully after 14 days. The symptoms had been acute for the first 12 hours and then had become more or less chronic. This is quite an isolated case. In the vast majority of cases in infants the process is essentially acute and those that survive beyond the 3rd or 4th day must be looked upon as exceptions..... The question of spontaneous recovery is one of very little importance in connection with the infantile type. Recovery may very occasionally occur from spontaneous reduction of the tumour, and then as a rule when an anaesthetic has been administered. In case 4 a completely reduced

1. Lancet, April 24th 1897.

ileocaecal intussusception was found when laparotomy was performed, and in case G the tumour had greatly diminished in size, so much so that the surgeon was unable to feel it before he opened the abdomen, although it had been quite definitely palpated half an hour previously ..... Still more uncommon in infants is the passage of a slough consisting of the intussusceptum. It did not occur in any of the 50 cases. Wiggins[1] found one example in 103 cases; a male infant, aged 7 months, who passed a slough on the 4th day and recovered. (Wiggins statistics as regards age, sex, etc. are practically identical with mine. He had, however, a large proportion of the ileocaecal variety - 89%). The process in infants is too acute and the resulting collapse and obstruction come on too soon to allow of the slow process of cicatrization which must accompany the separation of a slough if it is not to be followed by peritonitis. Wiggin estimates that 98% of cases if left to nature will die from the immediate or remote effects. Spontaneous recovery, then, must never be expected or reckoned on. The prognosis is of the very gravest, once a diagnosis has been definitely established, and for practical purposes we may say that the infant will be dead in a matter of hours

1. Lancet August 28th, 1897.

or at most days unless prompt treatment is resorted to.

TREATMENT.

The treatment of intussusception has for centuries been a matter of continual dispute, and, although within recent years the question has been thrashed out from every point of view, differences of opinion still exist and the dispute is only slowly showing signs of settlement ..... I do not intend to discuss the treatment by manipulation and massage of the tumour through the abdominal wall, as these procedures are acknowledge by everyone who has a right to express an opinion to be not only useless, but absolutely dangerous. Any one who has examined a case carefully will know the difficulty of ascertaining the exact relations and attitude of the tumour, and, therefore, of deciding how to commence and in what direction to continue the manipulation. The practice is obviously unscientific and may be condemned without further comment ..... Two distinct methods of treatment are employed, first, the injection of air or water into the bowel; and, second, reduction by manipulation after laparatomy. As the first method has still numerous supporters it will be necessary to carefully consider the respective merits of the two procedures. I would say

at once that in my opinion immediate laparotomy in every case is the only line of treatment likely to yield any manner of success over a large number of cases. Several writers indicate that such will probably soon be the recognised form of treatment and many surgeons now recommend it; but in no text book of Surgery or Children's Diseases have I found prompt surgical treatment absolutely insisted upon. All countenance at least a trial of the distension procedures. It is interesting to note in looking through these books that closer and closer limits are being set as to the time during which mechanical treatment is justifiable. Eustace Smith[1] thinks that they should not be relied upon after the 4th day of the disease. Keen[2] fixes a limit of 48 hours. D'Arcy Power[3] recommends their use up to 48 hours. John Thomson[4] states that they are "frequently successful in reducing intussusception if it is of recent occurrence". Treves[5] points out the great disadvantages of this treatment, but permits it within 12 hours of the onset. Cheyne and Burghead[6] recommend a combined laparotomy and injection in the early stages. Ashby and Wright[7] fix no limit, but

1. Disease in Children 1884.
2. Reating, Cyclopaedia of Diseases of Children 1890.
3. Edinburgh Medical Journal, June 1897.
4. Clinical Examination and Treatment of Sick Children 1898.
5. Intestinal Obstruction 1899.
6. Surgical Treatment, 1902.
7. Diseases of Children, 1899.

indicate that surgical opinion leans to abdominal section in all cases. Koplik[1] allows enemata once, at once, if at all. Holt[2] restricts their use to the first three hours. The old method, then, dies hard. The most recent publications still give it an honoured position, but exclude it politely by putting limits to its use which place it outside the range of practical treatment ..... What are the points in its favour? We are told that it raises little parental opposition. This cannot be contradicted and if anyone considers such a reason sufficient excuse for persevering in bad treatment, nothing more need be said. Secondly, the means for its performance are always at hand; which is certainly true, and it must be admitted that in a remote district where much time must necessarily elapse before surgical aid can be procured, these methods might quite fairly be employed in the early stages. But this reason can only apply to a small percentage of the cases, and it in no way affects the main line of argument. Thirdly, infants are said to stand operative procedures very badly. This is most certainly an ill founded superstition. The same argument was advanced against the radical cure of hernia in infants, and yet an Edinburgh surgeon has recently operated on

1. Diseases of Infancy and Childhood, 1903.
2. Diseases of Infancy and Childhood, 1903.

200 such cases in succession without a single death. A reference to cases C and D will prove that the mere laparotomy has very much less effect in children than in adults. Death results not from the operation but from the delay that preceded it. Lastly, the possibility of ventral hernias following laparotomy has been pointed out. These are very rare as the above statistics show, and are easily cured when they do occur. In any case a hernia is a small matter compared with the life of the individual ..... Apart from actual results there are several theoretical objections to this line of treatment:-

1. We can neither see what we are doing nor can we know when to stop. We cannot be sure that the intussusception has been reduced; for, on the one hand, a thickening of the bowel, consequent upon the invagination, may be mistaken for an unreduced tumour and the treatment kept up a needlessly long time and with dangerous force; and, on the other hand, the last inch or so of the invagination (the most difficult part to reduce) may entirely escape detection, and we will then stop too soon.

2. One can never tell beforehand that any particular case is suited to this procedure. It may entirely fail in what appears to be a most favourable case. Further, we cannot know what is the state of the gut which we propose to submit to strain. It

may be friable, in a state verging on gangrene, and unable to withstand even slight distension.

3. In those cases in which it fails not only is valuable time lost, but the patient's condition is rendered very much worse and the prospects of a successful laparotomy greatly diminished. The tumour may be to all appearances gone; but if it is not the combined effects of the anaesthetic, of opium (which is always recommended), and of shock from the distension retard the reappearance of definite symptoms for several hours. Were it possible to employ these measures unsuccessfully without prejudicing the chances of the patient, one of the chief objections to their use would be removed; but this is very far from being the case. Numerous cases are on record of repeated recurrence after treatment by injection. It is certain that most of these have not been recurrences at all, but simply renewed growths of a tumour which has never been completely reduced.

4. They are absolutely useless in the enteric forms, because fluids cannot pass the ileocaecal valve; and probably also in the ileocolic because of the tight grip that the valve takes of the ileum.

5. True recurrence seems to be more common after reduction in this way than after operative measures. D'Arcy Power thinks that this is probably due to the dilatation of the colon produced by the

distending agent.

To come to a more practical question, let us consider what,if any, are the dangers of this mode of treatment apart from the loss of time. It must be left to the advocates of the method to decide whether inflation or irrigation of the bowel is to be adopted. Inflation by air or gases still finds some supporters, and much ingenuity has been manifested in multiplying the means by which it can be carried out. Air may be introduced by means of an ordinary bellows, a Higginson's Syringe or a Lund's Insufflator - an instrument fitted with an india-rubber collar to prevent the return of gas alongside of the rectal tube. Carbonic acid gas has been used, and it can be generated inside the bowel by introducing separately Soda Bicarbonate and Citric or Tartaric Acid in solution; or outside the body in some closed receptacle. For the latter purpose Lundie has introduced a special modification of the domestic gasogene with a rectal tube attached. Senn, who carried out numerous experiments on this subject, recommended Hydrogen. It has even been recommended that the rectum should be plugged to allow of the accumulation of intestinal gases. Gases are alleged to have an advantage over fluids in being capable of passing the ileocaecal valve and reducing an enteric

intussusception. No successful case, however, has been recorded, and our knowledge of the pathology of acute enteric invaginations makes us doubt very much if one ever will be. Irrigation has now almost entirely superseded inflation for the purpose of distension. Water is more easily controlled than gas, and its amount and force can be more accurately estimated. It is introduced by means of a rectal tube the required force being obtained by holding the filler a certain height above the bed. As the result of experimental work very definite limits have been set as to the head of water to be employed. Such restrictions will certainly minimise the direct dangers of the method and diminish the number of accidents. It is now usually stated that the water should be introduced slowly, in a steady stream, and from a height not exceeding three feet. Formerly much greater force was permitted. Rotch[1] recommends a head of 6 feet accompanied by massage of the abdomen. An American writer advised that the child should be placed in the ball and the water poured down a tube from the first landing! The amount of fluid to be introduced apparently has to be roughly estimated from the age of the patient. D'Arcy Power[2] found the capacity of the colon at different ages

1. Hygienic and Medical Treatment of Children.
2. Edinburgh Medical Journal, June 1897.

to be a very uncertain quantity. Between 5 and 9 months it varies from 10 to 16 ounces.

The experiments of Mortimer[1] on the bodies of children are of interest in connection with treatment of irrigation. His method was to open the abdomen, ligature the ileum, and then close the abdomen before introducing the fluid per rectum. He pointed out that when the abdominal wall is flaccid, as is usually the case when a child is under chloroform, the whole distending force of the water would act on the bowel wall. If during introduction any kink occurred in the colon, the whole distending force would act on the bowel wall below the kink and the colon would very readily rupture. The same effect would be produced during life by a sudden contradiction of any portion of the bowel. Out of 21 cases Mortimer found that in only 2 could the water be raised to 11 feet without some damage to the bowel resulting. In many cases peritoneal cracks occurred when the height was only 5 feet (equivalent to 2½ lbs to the square inch). In the majority a head of 8 feet caused similar damage, and in some 6 feet was sufficient to completely rupture the bowel. He noticed that rupture was most likely to occur at the splenic

1. Lancet, May 23rd 1891.

flexure or transverse colon. Mole[1] arrived at practically the same results by experiments performed with the abdomen open. He observed that complete rupture was usually preceded by a longitudinal splitting of the serous coat ..... When applied to actual practice these results lose a good deal of their value, because the experiments were performed on dead bodies and on intestines that were in no way diseased. A pressure of 2½ lbs to the square inch or even more may be applied to a healthy bowel wall without immediate risk, but how are we to know that in any given patient the gut may not be - as is often found at operation - so friable from congestion and pressure that the slightest pressure would tear it like paper? Again, if an ileocaecal intussusception has travelled round to the splenic flexure and consequently diminished the capacity of the colon, what fraction of the amount of fluid that the healthy colon would accomodate are we to introduce? Records show that even when the greatest caution is employed, rupture may occur - and this is just exactly what we would expect. Lawford Knaggs[2] collected 7 cases in which rupture of the bowel from the introduction of air or water had caused death. In one of them

1. Bristol Med. Chir. Journal 1894.
2. Op. cit.

laparotomy was performed after the rupture had occurred and it was found that the intussusception could be reduced with the greatest ease. These cases were all published by men whose reputation was great enough to enable them to do so without fear of disgrace; and the very fact that such accidents have occurred in the hands of skilled surgeons indicates clearly that very many more must have taken place under less experienced practitioners. We are told to let the distending force continue acting until a "giving way" occurs and the area of the abdomen occupied by the colon becomes distended. But this "giving way" and distension are exactly the signs that follow rupture of the bowel. If we then administer opium and put the patient back to bed, the condition will be hopeless by the time the accident becomes apparent. As mentioned above, reduction may appear to have been accomplished, and yet an inch or so of invaginated bowel is left to restart the process, and leave the condition worse than before with several valuable hours lost. Lastly, a bad tear of the bowel short of complete rupture, or a small leak, may escape detection and lay the foundation of a rapid and fatal peritonitis. Taking everything into consideration, it would appear that the only safe thing to do in the interests of the

patient is to open the abdomen immediately after the performance of irrigation to make sure that everything is right; or to follow the plan recommended by Cheyne and Burghard and perform the irrigation with the abdomen open. If so, why not avoid the risks and bother of these clumsy procedures altogether?

The advantages of immediate laparotomy are obvious, if it is granted that irrigation is at the best uncertain and at the worst dangerous. The condition of the tumour and its relations are seen. The intussusception, if reducible, is unfolded by gentle pressure from below, acting through the sheath without injury to the bowel; if irreducible, the position is at any rate better than if enemata were being employed, and resection of the involved bowel can be proceeded with - a forlorn hope certainly, but still the only rational treatment. A gangrenous appendix can be removed as was done in case No.50. Tendency to recurrence can be diminished by fixing the terminal position of the ileum by stitches through its mesentery so as to make it descend towards the caecum. In an uncomplicated case the whole operation need not occupy more than 20 minutes. By careful manipulation many cases can be reduced which it would have been quite hopeless to attack by

distension ..... But if good results are to be obtained from laparotomy all cases must be subjected to it as soon as a diagnosis is made. The patient's chances must not be prejudiced by wasted time and increased shock caused by other procedures. Laparotomy must not be regarded as a dread last resource; if it is, the results will most certainly fulfil the anticipation. And if a case is absolutely hopeless and bound to succumb, no matter what treatment is employed, laparotomy may be done as the only possible line of treatment indicated; but such cases must not be included in statistics used to contrast the advantages of the two methods.

Statistics are notoriously misleading; but in this disease, I regret to say, they are entirely unreliable. Were it not so, I have no doubt that actual results would make out an overwhelmingly strong case for laparotomy. I think that in intussusception particularly there is a tendency to record successful cases, not unsuccessful ones; because in the practice of most surgeons the cases are uncommon and when death occurs, there is generally no special feature in the case that is considered worthy of publication. Again, so many of the cases have been subjected to both methods of treatment and this further complicates matters. To draw conclusions of any value

from statistics one would require to have two extended series of cases; one series treated by irrigation and the unsuccessful cases which afterwards succumbed to operation counted as deaths; and the other series treated by laparotomy and not to include cases which had previously been failures under irrigation and which died after operation. Such an arrangement would, if anything, give the advantage to the first series which would take no note of cases which were cured by laparotomy after having been treated by mechanical means without result. Information of this kind is not obtainable. In recording an operation case, writers rarely state whether or no other procedures were first tried. Cases coming to hospital usually have a history that the doctor gave an enema; but whether this was before a diagnosis was come to and was meant to relieve the bowels, or was introduced for the purpose of reduction of an intussusception is a difficult and delicate question to elucidate. Then a considerable proportion of cases are sent for treatment when it is too late to save them by any method, and, although laparotomy is of course performed, these cases which could never have increased the number of recoveries from irrigation simply serve to swell the number of deaths from operation. As will be seen

from the above tables every patient who was subjected to resection of the bowel died; but these cases would just as certainly have been lost had they been left alone or treated in any other way. If an intussusception is reduced easily by operation and afterwards dies, it may quite fairly be asserted that the patient might have been saved by injection, but under no other circumstances must this contention be raised.

Of the above 50 cases, 44% recovered. In 1896 Wiggin[1] collected 39 cases treated by enemata or inflation with 41% of recoveries. It is impossible to correct these figures as I have suggested above, but if cases which required resection, and were, therefore, incurable by any other means, are excluded from my lists, the recovery rate rises to 61%. Wiggin also collected 64 cases treated by laparotomy and of these 32.8% recovered. and with resection cases excluded 47.6%. If one could exclude from the operation mortalities cases that had already been unsuccessfully treated by other means these figures, satisfactory as they are, would undoubtedly be greatly improved. Wiggin points out that the results from laparotomy had greatly improved in the 7 years immediately preceding public-

1. Op. cit.

ation during which period over 77% of the patients subjected to simple laparotomy and reduction had recovered. The same progressive inprovement is to be noted in my tables. The last 19 cases show only 2 deaths, one a resection case and the other an infant who was moribund on admission to hospital. Cuthbert Wallace[1] at a recent meeting of the Clinical Society of London gave particulars of 20 operation cases with 80% of recoveries over all, and 89% when resection cases were not included. At the same meeting C. H. Fagge[1] detailed 18 cases treated by laparotomy with 61% successful and 84% recoveries in reducible cases. Bernard Pitts[2] was able to publish 7 consecutive laparotomies for intussusception with only one death. No good end can be served by multiplying incomplete statistics. In any small collections of cases that I have come across, a 41% recoveries by mechanical methods was never exceeded and most of the operation publications consisted of one or two successful cases and were, therefore, useless. It will thus be seen that even with the great disadvantages that the surgical treatment of this disease has to face from delay and employment of other methods, the actual results from laparotomy are far in advance of those from injections. In recent years, owing doubtless to the

1. British Medical Journal, 17th December 1904.
2. Lancet, 12th June 1897.

fact that the medical profession generally is becoming alive to the urgency of the condition and the necessity of prompt treatment, extremely favourable results have been obtained in what used to be looked upon as one of the most deadly diseases of infancy. When we remember that intussusception occurs most commonly in healthy male children - those, that is to say, of greatest future value to the state - we must admit that the question is one requiring the most serious and unprejudiced consideration. I hope I have shown that immediate operation is the treatment that not only commends itself to the reason, but gives by far the best results. It is monstrous that because an occasional case can be cured by injections, hundreds of children should die every year from intussusception; and one may fairly call it a calamity that even one case should ever have recovered by these means.

The details of the operation for a simple reduction are so simple that I need not describe them at any length. The abdomen is best opened in the middle line above the umbilicus in most cases, but the incision must vary according to the position of the tumour. An opening of from $2\frac{1}{2}$ to 3 inches usually gives abundance of room. The tumour should be brought into the wound if possible. There is

no advantage in attempting to reduce it as it lies. Reduction is to be accomplished by expression of the intussusceptum from below by pressure applied through the sheath. Traction on the entering tube is never to be used. Great care will frequently be required in dealing with the last inch or so, especially in ileocaecal cases, because it is when almost the whole mass has been reduced that the most congested portion, namely the apex, has to be dealt with. Gentle patient manipulation is to be persevered with. A very helpful procedure is to envelop the mass in a swab and compress it steadily for about a couple of minutes - just as is done with the glans penis in a case of paraphimosis. This diminishes the congestion and swelling and often enables reduction to be accomplished with surprising facility. If the ileum lies in a position of ascent towards the colon, and recurrence is feared, the mesentery should be united to the ascending mesocolon by catgut sutures, so as to hitch up the terminal portion of the ileum and make it descend to the ileocaecal junction. The reason for this is fully described above. Some surgeons prefer to simply shorten the mesentery by folding it on itself.

When the tumour is irreducible, the outlook is practically hopeless. The following are the procedures that have been employed.

1. An artificial anus may be made above, or a lateral anastomosis established between the bowel above and that below the intussusception, the tumour being left inside the abdominal cavity. It is difficult to conceive how any but uniformly fatal results could be expected from such measures.

2. The whole intussusception may be excised and the divided ends of bowel fixed in the wound to form an artificial anus. There is no record of a successful case in an infant from this method.

3. After excision of the intussusception an end to end suture of the divided ends may be performed either with silk stitches alone or with the aid of a button. This is probably the correct treatment, but as all methods have been attended with such a fearful death rate in infants, it is difficult to compare results. Clubbe[1] recorded a successful case in a child of 11 months. Jacob Frank reported another of 9 months at the Chicago Surgical Society in November 1904.

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1. British Medical Journal. November 6th 1897.

4. A hole may be made in the sheath and the intussusceptum excised as was recommended by Barker[1]. This method has the advantage that occasionally it is found possible to complete reduction after the sheath has been opened, in which case, of course, the hole made is simply stitched up again. The first step, then, is to make a longitudinal incision in the intussuscipiens along the part furthest from the mesentery. If reduction is still impossible the entering tube and the sheath are united by a continuous silk suture all round the neck on the outside. The intussusceptum is then drawn out of the opening in the sheath and amputated as high up as possible. In doing this, both the inner and middle layers of bowel are divided. A small portion of the circumference is cut at a time and the two layers firmly united with a silk suture. Another portion is then treated similarly and so on until the whole ring has been divided and sutured. The intussusceptum is then removed entirely and the incision in the sheath closed. This proceeding suggested itself to Barker after he had amputated a colic intussusception that was protruding from the anus[2] by the same steps as I have described

1. Lancet, January 9th 1892.
2. Med. Chir. Transactions Vol.LXX.

above except, of course, that no incision was required. This operation has many points in its favour and in a suitable case should most certainly be employed. In infants, however, the irreducible portion is as a rule so extremely short that the operation would be difficult to carry out. Resection with end to end suture would not involve much sacrifice of bowel wall under such circumstances and would probably be preferable on the whole ..... When the whole tumour is gangrenous, resection with end to end suture must be undertaken as a forlorn hope. If the condition of the patient is so bad as to forbid even this, the gangrenous mass should simply be fixed outside the abdominal wall in the hope that if the patient survives an artificial anus may form and the tumour slough away.

In a simple case the abdominal wound may usually be closed completely. If any part of the bowel wall is suspicious in appearance, a small gauze drain should be inserted down to it and left in for 2 or 3 days. The best way to close the abdominal wall is by means of silk worm gut sutures through all layers and threaded externally through short pieces of rubber tubing to prevent them cutting the skin which they are very apt to do in infants if left unprotected.

After the operation the patient must be surrounded with hot bottles and all means employed that will be likely to lessen the shock if it is severe. The use of opium has been almost universally recommended. It is to be given as soon as the condition is diagnosed; after enemata and inflations; after operations - in fact at all times and stages because it quiets the bowel and retards the formation of invagination. Now the real danger and anxiety after operation arise not from the possibility of recurrence, but from the effects of the obstruction, and paralysis and distension of the affected bowel. Opium of all drugs will tend to increase this, and therefore to intensify the toxaemia arising from obstruction. A mild purge is therefore more strongly indicated ..... Before operation opium is indicated, when a clear diagnosis has been come to, in order to allay the suffering during the time that must elapse before the operation can be done, and to prevent increase in the size and congestion of the tumour[1] ..... The best purgative to give is, I think, Calomel. It combines the advantages of a peristaltic stimulant and an intestinal antiseptic. It should be given in small doses frequently and may be started almost at once if there is no sickness. When there is much

1. It need hardly be said that purgatives before reduction are absolutely contraindicated.

distension and nothing is being passed by the bowel I have found strych nine in full doses hypodermically to be very beneficial. Physostigmine has given good results under similar circumstances after abdominal operations on older children, but I have never ventured to try it in infants. The main object of treatment after reduction is to get the bowels to move, and sedatives will certainly increase the paralytic distension, although they may allay symptoms and hide the gravity of the patient's condition.

Diluted milk by the mouth in small quantities may be started at once if the child seems hungry and in any case in an hour or two if there is no sickness. If vomiting is troublesome, salines per rectum or subcutaneously must be given until feeding by the mouth can be commenced.

As regards stimulants, I am convinced that they are most injurious. Many an infant whose life hangs in the balance has the scale turned against him by the injudicious use of strophanthin, digitalin and strychnine. Every authority on Diseases of Children emphasises the fact that infants tolerate these drugs very badly even in health; and yet, after abdominal operations, the notes show that they are generally all given and in almost lethal doses

apparently with the idea that if they do no good, they can do no harm. Any child who survives the initial shock of an operation for intussusception will show a marked stage of reaction during the first few hours whether stimulants are given or not. The subnormal temperature rises to perhaps 102°or 103o; the small almost imperceptible pulse becomes full and rapid; the pallid damp cold skin becomes flushed, dry and hot. If stimulants are being used, all this is attributed to them, whereas they are simply overdriving a heart that is already doing all that is necessary and overstimulating an already active nervous system.with the result that when the reaction begins to decline the child dies of exhaustion and toxaemia. Digitalin and strophanthin should be excluded altogether and strychnine only given with caution. The best means of tiding the patient over the initial shock,and,if necessary, maintaining his strength, is by means of saline infusions, saline by the rectum, and, if necessary, small doses of alcohol. The vomiting and starvation preceding operation must diminish the body's supply of fluid, and for this reason there is an additional advantage in the use of saline. Cases that are done early usually require no after treatment at all. The child's hungry cry soon demands

food and I have never seen any harm result from gratifying his desires. It is not necessary to keep the baby long on his back. The stitches may be taken out on the 9th or 10th day and a couple of days later the patient can be discharged if all is well.

NOTE:

Since the above was written Mr Stiles has operated on two further cases and both have recovered.

1. Female. Age 6 months. Onset sudden. Blood and mucus passed. Good deal of collapse. Pulse 168. Temperature 98·4°, Ileocaecal. Operation performed 30 hours after onset. No previous gastro-intestinal disturbance.

2. Male. Age 6 months. Onset sudden. Blood and mucus passed. Very marked collapse. Pulse 144. Temperature 97°, Ileocaecal. Operation performed 4 days and 11 hours after onset. No previous gastro-intestinal disturbance.

This is a most remarkable case on account of the very long duration. There was complete obstruction and no remission of symptoms and therefore

it seems certain that the intussusception had actually been in existence for $4\frac{1}{2}$ days. Reduction was accomplished with difficulty, but there was no gangrene.